VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

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VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
NORTH ANNA POWER STATION UNIT NOS. 1 AND 2
INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Enclosed is the 2010 Annual Radioactive Effluent Release Report. This report is provided pursuant to North Anna Units 1 and 2 Technical Specification 5.6.3 [10 CFR 50.36a] and North Anna Independent Spent Fuel Storage Installation Technical Specification 5.5.2c [10 CFR 72.44(d)(3)].

If you have any questions or require additional information, please contact Donald Taylor at (540) 894-2616.

Very truly yours,

N. Larry Lane
Site Vice President

Enclosure

Commitments made in this letter: None

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ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

NORTH ANNA POWER STATION

(JANUARY 01, 2010 TO DECEMBER 31, 2010)

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FORWARD

This report is submitted in accordance with North Anna Unit 1 and 2 Technical Specification 5.6.3 and North Anna Independent Spent Fuel Storage Installation (ISFSI) Technical Specification 5.5.2.c and 10CFR72.44(d)(3).

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

FOR THE

NORTH ANNA POWER STATION

JANUARY 01, 2010 TO DECEMBER 31, 2010

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1.0 EXECUTIVE SUMMARY

The Annual Radioactive Effluent Release Report describes the radioactive effluent control program conducted at the North Anna Power Station and Independent Spent Fuel Storage Installation (ISFSI) during the 2010 calendar year. This document summarizes the quantities of radioactive liquid and gaseous effluents and solid waste released from the North Anna Power Station and ISFSI in accordance with R.G. 1.21 during the period January 1 through December 31, 2010, and includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents. There were no releases from the ISFSI during 2010.

There were no unplanned releases, meeting the reporting criteria of section 6.7.2.a.3 of the Offsite Dose Calculation Manual during this reporting period. Neither were there any spills or leaks meeting the reporting criteria of the NEI Ground Water Protection Initiative. However, a voluntary communication was made under NEI-07-07 due to sample results from one ground water well, Piezometer Well #3.

Based on the 2010 effluent release data, 10 CFR 50, Appendix I dose calculations were performed in accordance with the Offsite Dose Calculation Manual. The results of these pathway dose calculations indicate the following:

a. The total body dose due to liquid effluents was 4.51E-1 mrem, which is 7.52% of the dose limit and the critical organ dose due to liquid effluents was 4.59E-1 mrem, which is 2.30% of the dose limit.

b. The air dose due to noble gases was 5.12E-3 mrad gamma, which is 2.56E-2% of the annual gamma dose limit, and 1.52E-2 mrad beta, which is 3.80E-2% of the annual beta dose limit.

c. The critical organ dose for I-131, I-133, H-3, and Particulates with half-lives greater than 8 days including C-14 was 1.16E+0 mrem, which is 3.87E+0% of the annual dose limit. The bases of these calculations are described in Attachment 9.

d. The critical organ dose for I-131, I-133, H-3, and Particulates with half-lives greater than 8 days not including C-14 was 2.19E-2 mrem, which is 7.30E-2% of the annual dose limit.

There were no major changes to either the radioactive liquid waste treatment system, or to the gaseous, and solid waste treatment systems during this reporting period.

There was one revision to the Offsite Dose Calculation Manual during this reporting period.

1.0 EXECUTIVE SUMMARY (cont.)

Based on the levels of radioactivity observed during this reporting period and the dose calculations performed, the operations of the North Anna Nuclear Power Station Units 1 and 2 and ISFSI have resulted in negligible dose consequences to the maximum exposed member of the public in unrestricted areas.

2.0 PURPOSE AND SCOPE

The Radioactive Effluent Release Report includes, in Attachment 1, a summary of the quantities of radioactive liquid and gaseous effluents and solid waste as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants", Revision 1, June 1974, with data summarized on a quarterly basis for Table 1 and 2 and on an annual basis on Table 3. The report submitted before May 1st of each year includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site during the previous calendar year. The report also includes a list of unplanned releases during the reporting period, in Attachment 6.

As required by Technical Specification, any changes to the Offsite Dose Calculation Manual (ODCM) for the time period covered by this report are included in Attachment 3.

Major changes to radioactive liquid, gaseous and solid waste treatment systems are reported in Attachment 4, as required by the ODCM, section 6.7.2.a.4. Information to support the reason(s) for the change(s) and a summary of the 10 CFR 50.59 evaluation are included. In lieu of reporting major changes in this report, major changes to the radioactive waste treatment systems may be submitted as part of FSAR updates.

As required by the ODCM, sections 6.2.2.b.2 and 6.3.2.b.3, a list and explanation for the inoperability of radioactive liquid and/or gaseous effluent monitoring instrumentation is provided in Attachment 5 of this report.

3.0 DISCUSSION

The basis for the calculation of the percent of Technical Specification for the critical organ in Table 1A of Attachment 1 is the ODCM, section 6.3.1, which requires that the dose rate for iodine-131 & iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days shall be less than or equal to 1500 mrem/yr to the critical organ at or beyond the site boundary. The critical organ is the child's bone if C-14 is included and child's thyroid if C-14 is not included both via the inhalation pathway.

The basis for the calculation of percent of Technical Specification for the total body and skin in Table 1A of Attachment 1 is the ODCM, section 6.3.1, which requires that the dose rate for noble gases to areas at or beyond the site boundary shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

The basis for the calculation of the percent of Technical Specification in Table 2A in Attachment 1 is the ODCM, section 6.2.1, which states that the concentrations of radioactive material released in liquid effluents to unrestricted areas shall be limited to 10 times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-4 μCi/ml.

Percent of Technical Specification calculations are based on the total gaseous or liquid effluents released for that respective quarter.

The annual and quarterly doses, as reported in Attachment 2, were calculated according to the methodology presented in the ODCM. The beta and gamma air doses due to noble gases released from the site were calculated at site boundary. The maximum exposed member of the public from the releases of airborne iodine-131 & iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days, including carbon-14 is defined as a child, exposed through the vegetation pathway, with the critical organ being the bone. If carbon-14 is excluded from these calculations, the maximum exposed member of the public from the releases of airborne iodine-131 & iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days, excluding carbon-14, is defined as a child, exposed through the vegetation pathway, with the critical organ being the thyroid gland. The maximum exposed member of the public for calculation of total body dose from radioactive materials in liquid effluents released to unrestricted areas is defined as a child, and also as a child for the calculation of critical organ dose, which was determined to be the liver. The age group is exposed via the drinking water and fish ingestion pathways.

As shown in Attachment 6 there were no unplanned releases meeting the requirements of 6.7.2.a.3 of the ODCM.

3.0 DISCUSSION (cont.)

The typical Lower Limit of Detection (LLD) capabilities of the radioactive effluent analysis instrumentation are presented in Attachment 7. These LLD values are based upon conservative conditions (i.e., minimum sample volume and maximum delay time prior to analysis). Actual LLD values may be lower. If a radioisotope was not detected when effluent samples were analyzed, then the activity of that radioisotope was reported as Not Detectable (N/D) on Attachment 1 of this report. If an analysis for an isotope was not performed, then the activity was reported as Not Applicable (N/A).

4.0 SUPPLEMENTAL INFORMATION

As required by the ODCM, section 6.6.2, evaluation of the Land Use Census is made to determine if new location(s) have been identified for the radiological environmental monitoring program pursuant to the ODCM. No changes were made as a result of the land use census in 2009.

Section 6.6.1.b.4 of the ODCM requires identification of the cause(s) for the unavailability of milk or leafy vegetation samples, and the identification of new locations for obtaining replacement samples. Milk samples, ODCM, section 6.6.1, were collected from one station during the period from January to April of 2010. The dairy at Station 12 sold its cows and discontinued milking operations in April 2010. Sampling Station 12 was discontinued and samples were obtained from a dairy at new station designated Station 12A. Vegetation samples were not collected from stations 14a, 15, 16, 21 and 23 from January through March and during November and December due to seasonal unavailability. All other vegetation samples were obtained.

Attachment 8 contains the results of samples associated with ground water protection sampling undertaken at North Anna to voluntarily comply with the Nuclear Energy Institute, NEI, Ground Water Protection Initiative. In addition to the well, river, and surface water samples included as part of the Radiological Environmental Monitoring Program, North Anna obtained subsurface water samples from various locations on the site.

Attachment 9 contains an explanation of the bases for the carbon-14 calculations performed to assess doses due to carbon-14. Doses and %TS for gaseous releases are displayed with C-14 included and without for comparison of the values.

ATTACHMENT 1

EFFLUENT RELEASE DATA

(01/10 - 12/10)

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste, as outlined in Regulatory Guide 1.21, Appendix B, except that in accordance with Step 6.7.2.a.1 of the ODCM liquid and gaseous data is summarized on a quarterly basis and solid waste is summarized on an annual basis.

TABLE 1A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF ALL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

	UNITS	1 ST QUARTER	2 ND QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Gases:				
1. Total Release	Curies	5.23E+01	1.24E+01	1.80E+1
2. Average Release Rate For Period	µCi/sec	6.73E+00	1.58E+00	
B. Iodines:				
1. Total Iodine-131 Release	Curies	1.19E-04	3.16E-04	2.80E+1
2. Average Release Rate For Period	µCi/sec	1.53E-05	4.02E-05	
C. Particulate ($T_{1/2}$ > 8 days):				
1. Total Particulate ($T_{1/2}$ > 8 days) Release	Curies	2.93E-05	8.37E-06	2.80E+1
2. Average Release Rate For Period	µCi/sec	3.77E-06	1.06E-06	
3. Gross Alpha Radioactivity Release	Curies	6.47E-08	1.82E-07	
D. Tritium:				
1. Total Release	Curies	1.93E+00	1.17E+00	3.10E+1
2. Average Release Rate For Period	µCi/sec	2.48E-01	1.48E-01	
E. Carbon-14				
1. Total Release	Curies	1.00E+01	2.39E+00	
2. Average Release Rate For Period	µCi/sec	1.29E+00	3.04E-01	
F. Percentage Of Technical Specification Limits				
1. Total Body Dose Rate	%	2.86E-03	2.20E-04	
2. Skin Dose Rate	%	1.13E-03	1.03E-04	
3. Critical Organ Dose Rate (with C-14)	%	2.11E-02	1.83E-03	
Critical Organ Dose Rate (without C-14)	%	2.12E-04	4.18E-04	

TABLE 1A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF ALL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

	UNITS	3 RD QUARTER	4 TH QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Gases:				
1. Total Release	Curies	2.29E+01	8.47E-01	1.80E+1
2. Average Release Rate For Period	µCi/sec	2.88E+00	1.07E-01	
B. Iodines:				
1. Total Iodine-131 Release	Curies	2.82E-04	9.67E-05	2.80E+1
2. Average Release Rate For Period	µCi/sec	3.55E-05	1.22E-05	
C. Particulate ($T_{1/2}$ > 8 days):				
1. Total Particulate ($T_{1/2}$ > 8 days) Release	Curies	8.97E-06	9.88E-06	2.80E+1
2. Average Release Rate For Period	µCi/sec	1.13E-06	1.24E-06	
3. Gross Alpha Radioactivity Release	Curies	4.59E-07	6.01E-08	
D. Tritium:				
1. Total Release	Curies	1.21E+00	4.74E-01	3.10E+1
2. Average Release Rate For Period	µCi/sec	1.53E-01	5.97E-02	
F. Carbon-14				
1. Total Release	Curies	4.39E+00	1.62E-01	
2. Average Release Rate For Period	µCi/sec	5.52E-01	2.04E-02	
F. Percentage Of Technical Specification Limits				
1. Total Body Dose Rate	%	3.86E-04	7.16E-06	
2. Skin Dose Rate	%	1.65E-04	3.84E-06	
3. Critical Organ Dose Rate (with C-14)	%	3.09E-03	6.72E-05	
Critical Organ Dose Rate (without C-14)	%	4.31E-04	2.47E-05	

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	1.44E+00	2.38E+00
Krypton - 85m	Ci	N/D	N/D	N/D	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	N/D	N/D
Xenon - 131m	Ci	N/D	N/D	4.73E-01	1.83E-01
Xenon - 133	Ci	7.58E+00	3.75E+00	6.37E+00	4.06E+00
Xenon - 133m	Ci	N/D	N/D	5.71E-02	6.77E-03
Xenon - 135	Ci	2.11E-03	1.02E-02	1.25E-02	N/D
Xenon - 135m	Ci	N/D	7.01E-03	N/D	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)		N/D	N/D	N/D	N/D
Argon - 41	Ci	9.84E-03	2.54E-02	N/D	N/D
Total For Period	Ci	7.59E+00	3.79E+00	8.35E+00	6.63E+00
Iodines:					
Iodine - 131	Ci	6.86E-07	7.67E-07	N/D	N/D
Iodine - 132	Ci	N/D	N/D	N/D	N/D
Iodine - 133	Ci	1.51E-07	N/D	N/D	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	8.37E-07	7.67E-07	N/D	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	N/D
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	N/D	N/D	N/D	N/D
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D
Cesium - 136	Ci	N/D	N/D	N/D	N/D
Cesium - 137	Ci	N/D	N/D	N/D	N/D

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Particulates: (cont.)					
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Total for Period (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	N/D	N/D
GROSS ALPHA:	Ci	N/D	N/D	N/D	N/D
TRITIUM:	Ci	1.42E+00	1.16E+00	4.32E-02	5.72E-04
CARBON-14	Ci	1.46E+00	7.27E-01	1.60E+00	1.27E+00

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	1.63E+00	1.03E-01
Krypton - 85m	Ci	N/D	N/D	N/D	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	N/D	N/D
Xenon - 131m	Ci	N/D	N/D	3.13E-01	2.44E-02
Xenon - 133	Ci	3.05E+00	1.93E-02	1.45E+01	6.82E-01
Xenon - 133m	Ci	N/D	N/D	1.09E-01	N/D
Xenon - 135	Ci	2.74E-03	N/D	6.69E-02	N/D
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)		N/D	N/D	N/D	N/D
Argon - 41	Ci	5.54E-03	N/D	N/D	N/D
Total For Period	Ci	3.06E+00	1.93E-02	1.66E+01	8.09E-01
Iodines:					
Iodine - 131	Ci	1.05E-05	7.05E-07	N/D	N/D
Iodine - 132		N/D	N/D	N/D	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Iodine - 134		N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	1.05E-05	7.05E-07	N/D	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	N/D
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	N/D	N/D	N/D	N/D
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 85	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D
Cesium - 136	Ci	N/D	N/D	N/D	N/D
Cesium - 137	Ci	N/D	N/D	N/D	N/D

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Particulates: (cont.)					
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Total for Period (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	N/D	N/D
GROSS ALPHA:	Ci	N/D	N/D	N/D	N/D
TRITIUM:	Ci	2.64E-01	1.66E-01	2.62E-02	1.47E-04
CARBON-14	Ci	5.87E-01	3.70E-03	3.18E+00	1.55E-01

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	1.05E-01	2.10E-02
Krypton - 85m	Ci	N/D	N/D	1.63E-04	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	2.95E-05	N/D
Xenon - 131m	Ci	N/D	N/D	3.09E-02	4.08E-03
Xenon - 133	Ci	N/D	N/D	3.58E+01	2.02E+00
Xenon - 133m	Ci	N/D	N/D	1.86E-02	N/D
Xenon - 135	Ci	N/D	N/D	3.82E-01	N/D
Xenon - 135m	Ci	N/D	N/D	5.78E-02	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Argon - 41	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	3.64E+01	2.05E+00
Iodines:					
Iodine - 131	Ci	1.15E-04	3.15E-04	3.01E-06	1.30E-08
Iodine - 132	Ci	N/D	N/D	7.64E-09	N/D
Iodine - 133	Ci	7.40E-05	N/D	1.71E-07	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	1.89E-04	3.15E-04	3.19E-06	1.30E-08
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	1.68E-06	N/D	3.27E-07
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	1.16E-06	4.68E-06	2.72E-05	4.75E-07
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Particulates: (cont.)					
Cesium - 137	Ci	9.86E-07	1.21E-06	N/D	N/D
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Rubidium-88 (T1/2 < 8 days)	Ci	N/D	N/D	3.85E-05	N/D
Cerium-143 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	1.05E-07
Total for Period (T1/2 > 8 days)	Ci	2.15E-06	7.57E-06	2.72E-05	8.02E-07
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	3.85E-05	1.05E-07
Total For Period	Ci	2.15E-06	7.57E-06	6.57E-05	9.07E-07
GROSS ALPHA:	Ci	6.47E-08	1.82E-07	N/D	N/D
TRITIUM:	Ci	N/D	N/D	4.65E-01	6.43E-03
CARBON-14	Ci	N/D	N/D	6.98E+00	3.91E-01

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	1.64E-02	4.47E-03
Krypton - 85m	Ci	N/D	N/D	3.96E-05	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	N/D	N/D
Xenon - 131m	Ci	N/D	N/D	1.11E-02	3.12E-03
Xenon - 133	Ci	N/D	N/D	3.18E+00	1.06E-02
Xenon - 133m	Ci	N/D	N/D	7.24E-03	N/D
Xenon - 135	Ci	N/D	N/D	7.97E-03	N/D
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Xenon-137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)	Ci				
Argon - 41	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	3.22E+00	1.82E-02
Iodines:					
Iodine - 131	Ci	2.69E-04	9.59E-05	2.31E-06	1.10E-07
Iodine - 132	Ci	N/D	N/D	9.16E-08	N/D
Iodine - 133	Ci	1.28E-05	N/D	1.64E-08	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	2.82E-04	9.59E-05	2.42E-06	1.10E-07
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	2.47E-07	5.21E-07
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	4.06E-06	N/D	8.59E-07	7.15E-07
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Particulates: (cont.)					
Cesium - 137	Ci	2.45E-06	6.06E-06	N/D	1.08E-06
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Chromium-51 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	3.89E-07
Zirconium-95 (T1/2 > 8days)	Ci	N/D	N/D	4.40E-07	3.64E-07
Niobium-95 (T1/2 > 8days)	Ci	N/D	N/D	9.09E-07	7.55E-07
Silver-110m (T1/2 > 8 days)	Ci	N/D	N/D	2.00E-10	N/D
Total for Period (T1/2 > 8 days)	Ci	6.51E-06	6.06E-06	2.46E-06	3.82E-06
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	6.51E-06	6.06E-06	2.46E-06	3.82E-06
GROSS ALPHA:	Ci	4.59E-07	6.01E-08	N/D	N/D
TRITIUM:	Ci	N/D	N/D	9.23E-01	3.08E-01
CARBON-14	Ci	N/D	N/D	6.17E-01	3.49E-03

TABLE 2A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT - SUMMATION OF ALL RELEASES FOR (01/10 - 12/10)

	UNITS	1 ST QUARTER	2 ND QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Products:				
1. Total Release (not including tritium, noble gas, and gross alpha).	Curies	1.38E-03	1.06E-03	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	4.53E-12	1.58E-12	
3. Percent of applicable limit (T.S.)	%	1.43E-05	4.53E-06	
B. Tritium:				
1. Total release activity.	Curies	8.70E+02	1.21E+02	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	2.85E-06	1.81E-07	
3. Percent of applicable limit (T.S.)	%	2.85E-02	1.81E-03	
C. Dissolved and Entrained Gases:				
1. Total release activity.	Curies	1.43E-02	6.27E-04	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	4.69E-11	9.36E-13	
3. Percent of applicable limit (T.S.)	%	2.35E-05	4.68E-07	
D. Gross Alpha Radioactivity:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
E. Volume of waste released: (prior to dilution).	Liters	1.43E+08	1.57E+08	3.00E+00
F. Total volume of dilution water used during the period.	Liters	3.05E+11	6.70E+11	3.00E+00

TABLE 2A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT - SUMMATION OF ALL RELEASES FOR (01/10 - 12/10)

	UNITS	3 RD QUARTER	4 TH QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Products:				
1. Total Release (not including tritium, noble gas, and gross alpha).	Curies	2.52E-03	2.51E-03	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	3.16E-12	4.39E-12	
3. Percent of applicable limit (T.S.)	%	9.80E-06	4.81E-06	
B. Tritium:				
1. Total release activity.	Curies	2.74E+02	6.99E+00	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	3.45E-07	1.22E-08	
3. Percent of applicable limit (T.S.)	%	3.45E-03	1.22E-04	
C. Dissolved and Entrained Gases:				
1. Total release activity.	Curies	1.15E-02	0.00E+00	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	1.45E-11	0.00E+00	
3. Percent of applicable limit (T.S.)	%	7.23E-06	0.00E+00	
D. Gross Alpha Radioactivity:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
E. Volume of waste released: (prior to dilution).	Liters	1.52E+08	1.26E+08	3.00E+00
F. Total volume of dilution water used during the period.	Liters	7.95E+11	5.72E+11	3.00E+00

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Products:					
Manganese - 54	Ci	2.43E-05	N/D	N/A	N/A
Iron - 55	Ci	N/D	N/D	N/A	N/A
Cobalt - 58	Ci	8.14E-05	3.33E-04	N/A	N/A
Cobalt - 60	Ci	1.23E-03	6.08E-04	N/A	N/A
Strontium - 89	Ci	N/D	N/D	N/A	N/A
Strontium - 90	Ci	N/D	N/D	N/A	N/A
Niobium - 95	Ci	N/D	N/D	N/A	N/A
Ruthenium - 106	Ci	N/D	N/D	N/A	N/A
Silver - 110m	Ci	3.19E-05	3.85E-05	N/A	N/A
Iodine - 131	Ci	N/D	N/D	N/A	N/A
Iodine - 133	Ci	N/D	N/D	N/A	N/A
Cesium - 134	Ci	7.14E-06	N/D	N/A	N/A
Cesium - 137	Ci	5.93E-06	7.79E-05	N/A	N/A
Barium-Lathanum - 140	Ci	N/D	N/D	N/A	N/A
Cerium - 141	Ci	N/D	N/D	N/A	N/A
Other (Specify)	Ci				
Niickel - 63 (T1/2 > 8 days)	Ci	N/D	N/D	N/A	N/A
Total for Period	Ci	1.38E-03	1.06E-03	N/A	N/A

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Dissolved & Entrained Noble Gases:					
Xenon - 133	Ci	1.43E-02	6.27E-04	N/A	N/D
Xenon - 133m	Ci	N/D	N/D	N/A	N/D
Xenon - 135	Ci	N/D	N/D	N/A	N/D
Xenon - 135m	Ci	N/D	N/D	N/A	N/D
Other (Specify)	Ci	N/D	N/D	N/A	N/D
Kr-88 (T1/2 < 8 days)	Ci	N/D	N/D	N/A	N/D
Kr-85 (T1/2 > 8 days)	Ci	N/D	N/D	N/A	N/D
Total for Period	Ci	1.43E-02	6.27E-04	N/A	N/D
Tritium	Ci	8.70E+02	1.21E+02	N/A	N/D
Gross Alpha	Ci	N/D	N/D	N/A	N/D

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Products:					
Manganese - 54	Ci	1.58E-05	N/D	N/D	N/D
Iron - 55	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	1.23E-03	1.94E-03	N/D	N/D
Cobalt - 60	Ci	8.09E-04	5.31E-04	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Niobium - 95	Ci	2.54E-05	4.10E-05	N/D	N/D
Ruthenium - 106	Ci	N/D	N/D	N/D	N/D
Silver - 110m	Ci	N/D	N/D	N/D	N/D
Iodine - 131	Ci	9.32E-05	N/D	N/D	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	7.74E-05	N/D	N/D	N/D
Cesium - 137	Ci	2.65E-04	N/D	N/D	N/D
Barium-Lathanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Niickel - 63 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period	Ci	2.52E-03	2.51E-03	0.00E+00	0.00E+00

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/10 - 12/10)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Dissolved & Entrained Noble Gases:					
Xenon - 133	Ci	1.15E-02	N/D	N/D	N/D
Xenon - 133m	Ci	N/D	N/D	N/D	N/D
Xenon - 135	Ci	N/D	N/D	N/D	N/D
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Argon - 41 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Krypton - 85 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period	Ci	1.15E-02	N/D	N/D	N/D
Tritium	Ci	2.74E+02	6.99E+00	N/D	N/D
Gross Alpha	Ci	N/D	N/D	N/D	N/D

TABLE 3
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS
FOR 01-01-10 THROUGH 12-31-10

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. Type of Waste	Unit	12-Month Period		Estimated Total Percent Error (%)
a. Spent resins, sludges, filters sludge,	m^3	3.36E+01	*	2.50E+01
evaporator bottoms, etc.,	Ci	2.88E+02		2.50E+01
b. Dry compressible waste, contaminated	m^3	1.61E+03	**	2.50E+01
equipment, etc.,	Ci	7.70E+00		2.50E+01
c. Irradiated components, control rods,	m^3	0.00E+00		2.50E+01
etc.,	Ci	0.00E+00		2.50E+01
d. Other (describe)				
Used oil/Blast media/Sewage/Gravel	m^3	2.12E+00	***	2.50E+01
Dessicant/Soil/Construction debris	Ci	6.32E-04		2.50E+01
Animal Carcasses				

2. Estimate of major nuclide composition (by type of waste)	(%)	(Ci)	Estimated Total Percent Error (%)
a. Co-58	3.21E+01	9.24E+01	2.50E+01
Co-60	2.03E+01	5.85E+01	2.50E+01
Ni-63	1.91E+01	5.50E+01	2.50E+01
Cs-137	1.05E+01	3.02E+01	2.50E+01
Cs-134	7.14E+00	2.05E+01	2.50E+01
Fe-55	5.09E+00	1.46E+01	2.50E+01
Mn-54	2.54E+00	7.29E+00	2.50E+01
H-3	1.53E+00	4.39E+00	2.50E+01
Ni-59	3.41E-01	9.81E-01	2.50E+01
C-14	2.88E-01	8.29E-01	2.50E+01
Eu-152	2.64E-01	7.59E-01	2.50E+01
b. Co-60	6.25E+01	4.82E+00	2.50E+01
Fe-55	1.86E+01	1.43E+00	2.50E+01
Cs-137	3.84E+00	2.96E-01	2.50E+01
Mn-54	3.34E+00	2.57E-01	2.50E+01
Co-58	3.24E+00	2.49E-01	2.50E+01
Cr-51	2.90E+00	2.23E-01	2.50E+01
Ni-63	1.54E+00	1.19E-01	2.50E+01
Zr-95	1.46E+00	1.13E-01	2.50E+01
Nb-95	1.24E+00	9.55E-02	2.50E+01
Zn-65	3.66E-01	2.81E-02	2.50E+01
c. none			
d. Co-60	6.10E+01	3.86E-04	2.50E+01
Fe-55	1.78E+01	1.12E-04	2.50E+01
Cs-137	1.04E+01	6.55E-05	2.50E+01
Ni-63	4.28E+00	2.70E-05	2.50E+01
Mn-54	2.55E+00	1.61E-05	2.50E+01
Sb-125	7.73E-01	4.89E-06	2.50E+01
Nb-95	5.86E-01	3.71E-06	2.50E+01
Co-58	5.44E-01	3.44E-06	2.50E+01
Cs-134	4.23E-01	2.67E-06	2.50E+01
Zn-65	3.86E-01	2.44E-06	2.50E+01
Zr-95	3.42E-01	2.16E-06	2.50E+01

TABLE 3
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF SOLID RADIOACTIVE WASTE
AND IRRADIATED FUEL SHIPMENTS
FOR 01-01-10 THROUGH 12-31-10

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
2	Truck	Clive, UT
5	Truck	Erwin, TN
12	Truck	Oak Ridge, TN

B. Irradiated Fuel Shipments (Disposition)

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

* (7) shipments containing resins were shipped to a licensed waste processor for processing.

* (1) shipment of filters was shipped to licensed facility for disposal.
(shipment also contained de-watered powdered resin)

* (1) shipment of filter waste was shipped to a licensed waste processor for processing.
(filters were transported with compactable wastes accounted for below)

** (10) shipments containing contaminated equipment, dry compressible waste / incinerable waste were shipped to a licensed waste processor for processing.
(1 shipment also contained filter waste accounted for above)
(1 shipment included oil)
(1 shipment included animal carcasses)

** (1) shipment of compactable waste was shipped to a licensed facility for disposal.
(shipment included de-watered powdered resin, charcoal, asbestos)

*** (1) shipment containing contaminated oil was shipped to a licensed waste processor for incineration.
(Shipment also contained dry compressible waste)

ATTACHMENT 2

ANNUAL AND QUARTERLY DOSES

(01/10 - 12/10)

An assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site for each calendar quarter for the calendar year of this report, along with an annual total of each effluent pathway will be made as required by ODCM Section 6.7.2.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Total Body Dose (mrem)	3.07E-1	4.31E-2	9.79E-2	2.50E-3	4.51E-1
Critical Organ Dose (mrem)	3.07E-1	4.46E-2	1.04E-1	2.48E-3	4.59E-1

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Noble Gas Gamma Dose (mrad)	4.20E-3	3.28E-4	5.83E-4	1.09E-5	5.12E-3
Noble Gas Beta Dose (mrad)	1.22E-2	1.14E-3	1.86E-3	4.35E-5	1.52E-2
Critical Organ (Child bone) Dose for I-131, I-133, H-3, Particulates with T½ > 8 days (including C-14) (mrem)	8.64E-1	1.06E-1	1.88E-1	5.81E-3	1.16E+0
Critical Organ (Child thyroid) Dose for I-131, I-133, H-3, Particulates with T½ > 8 days excluding C-14 (mrem)	3.46E-3	8.24E-3	7.56E-3	2.62E-3	2.19E-2

ATTACHMENT 3

REVISIONS TO OFFSITE DOSE CALCULATION MANUAL

(ODCM)

(01/10 - 12/10)

As required by Technical Specification 5.5.1, revisions to the ODCM, effective for the time period covered by this report, are summarized in this attachment.

There was one revision made to the ODCM in 2010.

Revision 16, which was effective 05/12/10, replaced station 12 with 12A and changed the calibration frequency of HP sampler flow meter from SA, semiannual, to R, 18 months. Certain Tank Level indicating devices were removed from Attachments 1 and 2 since they are not effluent instrumentation.

See Revision Summary of affected procedure for more details.

Station Administrative Procedure

Dominion®

Title: Offsite Dose Calculation Manual (North Anna)

Process / Program Owner: Manager Radiological Protection and Chemistry (North Anna)

Procedure Number	Revision Number	Effective Date
VPAP-2103N	16	On File

Revision Summary

Revised to incorporate SAA005787

Details:

- Attachment 6: Rewrote ACTION 3 to provide additional clarity to grab sampling expectations (SAA005787)

Other revisions requested by Staff Health Physicist based on feedback from HP Ops and other departments

Details:

- Step 7.1: Updated procedure reference - VPAP-1701 to RM-AA-101
- Moved Commitments 3.2.1 through 3.2.6 to References 3.1.31 through 3.1.36. These items are not commitments in accordance with fleet procedure LI-AA-110, Commitment Management.
- Attachment 1: Deleted Section 2 (Tank Level Indicating Devices). Not liquid effluent monitoring instrumentation not required by NRC. These devices are covered by another process.
- Attachment 2: Deleted Section 2 (Tank Level Indicating Device). Not liquid effluent monitoring instrumentation not required by NRC. These devices are covered by another process.
- Attachment 7: Changed the HP Sampler Rotameter channel Calibration Frequency from Semi-Annual (SA) to Refueling (R) - Consistent with the MGPI monitors
- Attachment 10: Replaced Terrell's Dairy and Holladay Dairy (both dairies closed) with Lakeside Dairy, changed Station number from 12 to 12A, and changed the distance (miles) from Unit 1.

SUPERSEDED

Approvals on File

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1.0 PURPOSE

The Offsite Dose Calculation Manual (ODCM) establishes requirements for the Radioactive Effluent and Radiological Environmental Monitoring Programs. Methodology and parameters are provided to calculate offsite doses resulting from radioactive gaseous and liquid effluents, to calculate gaseous and liquid effluent monitoring alarm/trip setpoints, and to conduct the Environmental Monitoring Program. Requirements are established for the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Report required by Station Technical Specifications. Calculation of offsite doses due to radioactive liquid and gaseous effluents are performed to assure that:

- Concentration of radioactive liquid effluents to the unrestricted area will be limited to ten times the effluent concentration values of 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases and 2E-4 μCi/ml for dissolved or entrained noble gases.
- Exposure to the maximum exposed member of the public in the unrestricted area from radioactive liquid effluents will not result in doses greater than the liquid dose limits of 10 CFR 50, Appendix I
- Dose rate at and beyond the site boundary from radioactive gaseous effluents will be limited to:
  - Noble gases – less than or equal to a dose rate of 500 mrem/yr to the total body and less than or equal to a dose rate of 3000 mrem/yr to the skin
  - I^{131}, I^{133}, and H^{3}, and all radionuclides in particulate form with half-lives greater than 8 days – less than or equal to a dose rate of 1500 mrem/yr to any organ
- Exposure from radioactive gaseous effluents to the maximum exposed member of the public in the unrestricted area will not result in doses greater than the gaseous dose limits of 10 CFR 50, Appendix I, and
- Exposure to a real individual will not exceed 40 CFR 190 dose limits

2.0 SCOPE

This procedure applies to the Radioactive Effluent and Environmental Monitoring Programs at North Anna Power Station.

SUPERSEDED

3.0 REFERENCES/COMMITMENT DOCUMENTS

3.1 References

3.1.1 10 CFR 20, Standards for Protection Against Radiation

3.1.2 10 CFR 50, Domestic Licensing of Production and Utilization Facilities

3.1.3 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operations

3.1.4 TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites

3.1.5 Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, Rev. 1, U.S. NRC, June 1974

3.1.6 Regulatory Guide 1.109, Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance With 10 CFR 50, Appendix I, Rev. 1, U.S. NRC, October 1977

3.1.7 Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Rev. 1, U.S. NRC, July 1977

3.1.8 North Anna Technical Specifications

3.1.9 North Anna Technical Requirements Manual (TRM)

3.1.10 NUREG-0324, XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, U.S. NRC, September 1977

3.1.11 NUREG/CR-1276, Users Manual for the LADTAP II Program, U.S. NRC, May, 1980

3.1.12 TID-4500, VCRL-50564, Rev. 1, Concentration Factors of Chemical Elements in Edible Aquatic Organisms, October, 1972

3.1.13 WASH 1258, Vol. 2, July 1973, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" For Radioactive Material in Light Water-Cooled Nuclear Power Reactor Effluents

3.1.14 NUREG-0597, User's Guide to GASPAR Code, U.S. NRC, June, 1980

3.1.15 Radiological Assessment Branch Technical Position on Environmental Monitoring, November, 1979, Rev. 1

3.1.16 NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Stations, October, 1978

3.1.17 NUREG-0543, February 1980, Methods for Demonstrating LWR Compliance With the EPA Uranium Fuel Cycle Standard (40 CFR Part 190)

3.1.18 NUREG-0472, Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors, Proposed Rev. 3, March 1982

SUPERSEDED

3.1.19 Environmental Measurements Laboratory, DOE HASL 300 Manual

3.1.20 NRC Generic Letter 89-01, Implementation of Programmatic Controls for Radiological Effluent Technical Specifications (RETS) in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program

3.1.21 North Anna UFSAR

3.1.22 Nuclear Reactor Environmental Radiation Monitoring Quality Control Manual, IWL-0032-361

3.1.23 North Anna Circulating Water System Modifications

a. DC-85-37-1 Unit 1

b. DC-85-38-2 Unit 2

3.1.24 Plant Issue (Deviation) N-1994-1137, Improper Placement of Emergency TLDs

3.1.25 ET N-05-0025, Justification for removing 1-SW-RM-108 from service when not in use

3.1.26 VPAP-2802, Notifications and Reports

3.1.27 0-PT-75.21, 1-SW-RM-108 Flow Verification

3.1.28 SAA001092, Non-SA SOER Effectiveness Review 93-1, Recommendation 3

3.1.29 NEI 07-07, Industry Ground Water Protection Initiative - Final Guidance Document

3.1.30 CA086406, Land Use Census Results

3.1.31 Quality Assurance Audit Report Number 91-03, Observation 08N

3.1.32 Quality Assurance Audit Report Number 92-03, Observation 02N

3.1.33 Quality Assurance Audit Report Number 92-03, Observation 04NS (Item 2)

3.1.34 Plant Issue (Deviation) N-1997-0926, Annual Radiological Effluent Release Report

3.1.35 Plant Issue (Licensing Commitment) N-2006-4026-R15, Groundwater Monitoring Action Plan

3.1.36 SOER 93-1, Diagnosis and Mitigation of RCS Leakage including SGTR

3.2 Commitment Documents

None

SUPERSEDED

4.0 DEFINITIONS

4.1 Channel Calibration

A channel calibration shall be the adjustment, as necessary, of the channel output such that it responds within the necessary range and accuracy to known values of the parameter that the channel monitors. The channel calibration shall encompass all devices in the channel required for channel operability. The channel calibration may be performed by means of any series of sequential, overlapping, or total channel steps.

4.2 Channel Check

A qualitative assessment, by observation, of channel behavior during operation. This assessment includes, where possible, comparison of the channel indication and status with other indications or status derived from independent instrumentation channels measuring the same parameter.

4.3 Channel Operational Test

A Channel Operational Test (COT) shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify OPERABILITY of all devices in the channel required for channel OPERABILITY. The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints required for channel OPERABILITY such that setpoints are within the necessary range and accuracy. The COT may be performed by means of any series of sequential, overlapping, or total channel steps.

4.4 Critical Organ

That organ, which has been determined to be the maximum exposed organ based on an effluent pathway analysis, thereby ensuring the dose and dose rate limitations to any organ will not be exceeded. Dose calculations to the critical organ will be evaluated in accordance with Technical Specifications 5.5.4 dose rate limits specified for any organ to verify these limits have not been exceeded.

4.5 Dose Equivalent I-131

That concentration of I^{131} (μCi/cc) that alone would produce the same thyroid dose as the quantity and isotopic mixture of I^{131}, I^{132}, I^{133}, I^{134}, and I^{135} actually present. Thyroid dose conversion factors for this calculation are listed in Table III of TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites. Thyroid dose conversion factors from NRC Regulatory Guide 1.109, Revision 1, may be used.

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4.6 Frequency Notations

NOTE: Frequencies are allowed a maximum extension of 25 percent.

NOTATION	FREQUENCY
D - Daily	At least once per 24 hours
W - Weekly	At least once per 7 days
M - Monthly	At least once per 31 days
Q - Quarterly	At least once per 92 days
SA - Semi-annually	At least once per 184 days
R - Refueling	At least once per 18 months
S/U - Start-up	Prior to each reactor start-up
P - Prior to release	Completed prior to each release
N.A. - Not applicable	Not applicable
DR - During the release	At least once during each release

4.7 Gaseous Radwaste Treatment System

A system that reduces radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing delay or holdup to reduce total radioactivity prior to release to the environment. The system comprises the waste gas decay tanks, regenerative heat exchanger, waste gas charcoal filters, process vent blowers, waste gas surge tanks, and waste gas diaphragm compressor.

4.8 General Nomenclature

χ = Chi: concentration at a point at a given instant (curies per cubic meter)

D = Deposition: quantity of deposited radioactive material per unit area (curies per square meter)

Q = Source strength (instantaneous; grams, curies)

= Emission rate (continuous; grams per second, curies per second)

= Emission rate (continuous line source; grams per second per meter)

4.9 Lower Limit of Detection (LLD)

The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that can be detected with 95 percent probability with only five percent probability of falsely concluding that a blank observation represents a "real" signal.

SUPERSEDED

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4.10 Members of the Public

Individuals who, by virtue of their occupational status, have no formal association with the Station. This category includes non-employees of Dominion who are permitted to use portions of the site for recreational, occupational, or other purposes not associated with Station functions. This category does not include non-employees such as vending machine servicemen or postal workers who, as part of their formal job function, occasionally enter an area that is controlled by Dominion to protect individuals from exposure to radiation and radioactive materials.

4.11 Operable - Operability

A system, subsystem, train, component, or device is operable or has operability when it is capable of performing its specified functions and all necessary, attendant instrumentation, controls, normal and emergency electrical power sources, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its functions are also capable of performing their related support functions.

4.12 Purge - Purging

Controlled discharge of air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, so that replacement air or gas is required to purify the confinement.

4.13 Rated Thermal Power

Total reactor core heat transfer rate to reactor coolant (i.e., North Anna – 2893 MWt).

4.14 Site Boundary

The line beyond which Dominion does not own, lease, or otherwise control the land.

4.15 Source Check

A qualitative assessment of channel response when a channel sensor is exposed to radiation. This applies to installed radiation monitoring systems. For MGPI monitors, a source check is the verification of proper computer response to continuous operational checks on the detector and the electronics.

4.16 Special Report

A report to NRC to comply with Subsections 6.2, 6.3, or 6.5 of this procedure. Also refer to VPAP-2802, Notifications and Reports.

4.17 Thermal Power

Total reactor core heat transfer rate to the reactor coolant.

4.18 Unrestricted Area

Any area at or beyond the site boundary, access to which is neither limited nor controlled by Dominion for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the site boundary used for residential quarters or for industrial, commercial, institutional and/or recreational purposes.

4.19 Ventilation Exhaust Treatment System

A system that reduces gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and High Efficiency Particulate Air (HEPA) filters to remove iodines and particulates from a gaseous exhaust stream prior to release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not Ventilation Exhaust Treatment System components.

5.0 RESPONSIBILITIES

5.1 Manager Radiological Protection and Chemistry

The Manager Radiological Protection and Chemistry is responsible for:

5.1.1 Establishing and maintaining procedures for surveying, sampling, and monitoring radioactive effluents and the environment.

5.1.2 Surveying, sampling, and analyzing plant effluents and environmental monitoring, and documenting these activities.

5.1.3 Analyzing plant effluent trends and recommending actions to correct adverse trends.

5.1.4 Preparing Effluent and Environmental Monitoring Program records.

5.2 Manager Nuclear Operations

The Manager Nuclear Operations is responsible for requesting samples, analyses, and authorization to release effluents.

SUPERSEDED

6.0 INSTRUCTIONS

NOTE: Meteorological, liquid, and gaseous pathway analyses are presented in Meteorological, Liquid, and Gaseous Pathway Analysis (Attachment 13).

6.1 Sampling and Monitoring Criteria

6.1.1 Surveys, sampling, and analyses shall use instruments calibrated for the type and range of radiation monitored and the type of discharge monitored.

6.1.2 Installed monitoring systems shall be calibrated for the type and range of radiation or parameter monitored.

6.1.3 A sufficient number of survey points shall be used or samples taken to adequately assess the status of the discharge monitored.

6.1.4 Samples shall be representative of the volume and type of discharge monitored.

6.1.5 Surveys, sampling, analyses, and monitoring records shall be accurately and legibly documented, and sufficiently detailed that the meaning and intent of the records are clear.

6.1.6 Surveys, analyses, and monitoring records shall be reviewed for trends, completeness, and accuracy.

6.2 Liquid Radioactive Waste Effluents

6.2.1 **Liquid Effluent Concentration Limitations**

a. Liquid waste concentrations discharged from the Station shall not exceed the following limits:

1. For radionuclides (other than dissolved or entrained noble gases), liquid effluent concentrations released to unrestricted areas shall not exceed ten times the effluent concentration values specified in 10 CFR 20, Appendix B, Table 2, Column 2.

2. For dissolved or entrained noble gases, concentrations shall not exceed 2E-4 μCi/ml.

b. If the concentration of liquid effluent exceeds the limits in Step 6.2.1.a., promptly reduce concentrations to within limits.

SUPERSEDED

c. Daily concentrations of radioactive materials in liquid waste released to unrestricted areas shall meet the following:

$$\frac{\text{Volume of Waste Discharged} + \text{Volume of Dilution Water}}{\text{Volume of Waste Discharged} \times \sum_{i} \frac{\mu\text{Ci/ml}_i}{\text{ACW}_i}} \geq 1 \quad (1)$$

where:

$\mu\text{Ci/ml}_i$ = the concentration of nuclide i in the liquid effluent discharge

ACW_i = ten times the effluent concentration value in unrestricted areas of nuclide i, expressed as µCi/ml from 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than noble gases, and 2E-4 µCi/ml for dissolved or entrained noble gases

6.2.2 **Liquid Monitoring Instrumentation**

a. **Radioactive Liquid Effluent Monitoring Instrumentation**

Radioactive liquid effluent monitoring instrumentation channels shown on Radioactive Liquid Effluent Monitoring Instrumentation (Attachment 1) shall be operable with their alarm/trip setpoints set to ensure that Step 6.2.1.a. limits are not exceeded.

1. Alarm/trip setpoints of these channels shall be determined and adjusted in accordance with Step 6.2.2.d., Setpoint Calculation.

2. If a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required by Step 6.2.2.a., perform one of the following:
   - Promptly suspend release of radioactive liquid effluents monitored by the affected channel
   - Declare the channel inoperable
   - Change the setpoint to an acceptable, conservative value

SUPERSEDED

b. **Radioactive Liquid Effluent Monitoring Instrumentation Operability**

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated operable by performing a Channel Check, Source Check, Channel Calibration, and Channel Operational Test at the frequencies shown in Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements (Attachment 2).

1. If the number of operable channels is less than the minimum required by the tables in Radioactive Liquid Effluent Monitoring Instrumentation (Attachment 1) perform the action shown in those tables.
2. Attempt to return the instruments to operable status within 30 days. If unsuccessful and the channel is required to be in service, then explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

c. **Applicable Monitors**

Liquid effluent monitors for which alarm/trip setpoints shall be determined are:

Release Point	Instrument Number
Liquid Radwaste Effluent Line	1-LW-RM-111
Service Water System Effluent Line	1-SW-RM-108
Condenser Circulating Water Line	1-SW-RM-130 2-SW-RM-230
Steam Generator High Capacity Blow-down Line	1-SS-RM-125 2-SS-RM-225

SUPERSEDED

d. **Setpoint Calculation**

NOTE: This methodology does not preclude use of more conservative setpoints.

1. Maximum setpoint values shall be calculated by:

$$S = \frac{CF_D}{F_E} \qquad (2)$$

where:

S = the setpoint, in µCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution

C = the effluent concentration limit for the monitor used to implement 10 CFR 20 for the Station, in µCi/ml

F_E = maximum design pathway effluent flow rate

F_D = dilution water flow rate calculated as:
$D = F_E + (218{,}000\ gpm \times \text{number of circ. pumps in service})$

2. Each of the condenser circulating water channels (e.g., SW-130, SW-230) monitors the effluent (service water, including component cooling service water, circulating water, and liquid radwaste) in the circulating water discharge tunnel beyond the last point of possible radioactive material addition. No dilution is assumed for this pathway. Therefore, Equation (2) becomes:

$$S = C \qquad (3)$$

The setpoint for Station monitors used to implement 10 CFR 20 for the site becomes the effluent concentration limit.

3. In addition, for added conservatism, setpoints shall be calculated for the liquid radwaste effluent line LW-111 and the Service Water System effluent line SW-108.

SUPERSEDED

4. For the liquid radwaste effluent line, Equation (2) becomes:

$$S = \frac{CF_D K_{LW}}{F_E} \quad (4)$$

where:

K_{LW} = The fraction of the effluent concentration limit, used to implement 10 CFR 20 for the site, attributable to the liquid radwaste effluent line pathway

5. For the Service Water System effluent line, Equation (2) becomes:

$$S = \frac{CF_D K_{SW}}{F_E} \quad (5)$$

where:

K_{SW} = The fraction of the effluent concentration limit, used to implement 10 CFR 20 for the Station, attributable to the service water effluent line pathway

6. The sum $K_{LW} + K_{SW}$ shall not be greater than 1.0.

6.2.3 **Liquid Effluent Dose Limit**

a. **Requirement**

At least once per 31 days, perform the dose calculations in Step 6.2.3.c. to ensure the dose or dose commitment to the maximum exposed member of the public from radioactive materials in liquid releases (from each reactor unit) to unrestricted areas is limited to:

1. During any calendar quarter:
   - Less than or equal to 1.5 mrem to the total body
   - Less than or equal to 5 mrem to the critical organ

2. During any calendar year:
   - Less than or equal to 3 mrem to the total body
   - Less than or equal to 10 mrem to the critical organ

SUPERSEDED

b. **Action**

If the calculated dose from release of radioactive materials in liquid effluents exceeds any of the above limits, prepare and submit to the NRC, within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that identifies causes for exceeding limits and defines corrective actions taken to reduce releases of radioactive materials in liquid effluents to ensure that subsequent releases will be in compliance with the above limits.

c. **Dose Contribution Calculations**

Dose contribution shall be calculated for all radionuclides identified in liquid effluents released to unrestricted areas based on:

$$D = \sum_i Q_i \times B_i \tag{6}$$

Where:

Subscripts = i, refers to individual radionuclide

D = the cumulative dose commitment to the total body or critical organ from the liquid effluents for the period t, in mrem

B_i = Dose Commitment Factors (mrem/Ci) for each age group of interest. Values for B_i are provided in code file for North Anna Power Station liquid pathway critical organ calculations

Q_i = Total released activity for the considered period and the ith nuclide

$$Q_i = t \times C_i \times \text{Waste Flow} \tag{7}$$

Where:

t = the period for which C_i and F are averaged for all liquid releases, in hours

C_i = the average concentration of radionuclide, i, in undiluted liquid effluent during the period, t, from any liquid releases, in μCi/ml

SUPERSEDED

d. **Quarterly Composite Analyses**

For radionuclides not determined in each batch or weekly composite, dose contribution to current monthly or calendar quarter cumulative summation may be approximated by assuming an average monthly concentration based on previous monthly or quarterly composite analyses. However, for reporting purposes, calculated dose contribution shall be based on the actual composite analyses.

6.2.4 **Liquid Radwaste Treatment**

Historical data pertaining to the volumes and radioactivity of liquid effluents released in connection with specific station functions, such as maintenance or refueling outages, shall be used in projections as appropriate.

a. **Requirement**

1. The Liquid Radwaste Treatment System shall be used to reduce the radioactive materials in liquid waste prior to discharge when projected dose due to liquid effluent, from each reactor unit, to unrestricted areas would exceed 0.06 mrem to total body or 0.2 mrem to the critical organ in a 31-day period.
2. Doses due to liquid releases shall be projected at least once per 31 days.

b. **Action**

If radioactive liquid waste is discharged without treatment and in excess of the above limits prepare and submit to the NRC, within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that includes the following:

1. An explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or sub-system, and the reason for the inoperability.
2. Actions taken to restore inoperable equipment to operable status.
3. Summary description of actions taken to prevent recurrence.

c. **Projected Total Body Dose Calculation**

1. Determine D_{TB}, the total body dose from liquid effluents in the previous 31-day period, per Equation (6).

SUPERSEDED

2. Estimate R_1, the ratio of the estimated volume of liquid effluent releases in the present 31-day period to the volume released in the previous 31-day period.
3. Estimate F_1, the ratio of the estimated liquid effluent radioactivity concentration in the present 31-day period to liquid effluent concentration in the previous 31-day period (µCi/ml).
4. Determine PD_{TB}, the projected total body dose in a 31-day period.

$$PD_{TB} = D_{TB}(R_1 F_1) \quad (8)$$

d. **Projected Critical Organ Dose Calculation**

1. Determine D_o, the critical organ dose from liquid effluents in the previous 31-day period, per Equation (6).
2. Estimate R_1 as in Step 6.2.4.c.2.
3. Estimate F_1 as in Step 6.2.4.c.3.
4. Determine PD_o = projected critical organ dose in a 31-day period.

$$PD_O = D_O(R_1 F_1) \quad (9)$$

6.2.5 **Liquid Sampling**

Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis requirements in Radioactive Liquid Waste Sampling and Analysis Program (Attachment 3).

6.3 Gaseous Radioactive Waste Effluents

6.3.1 Gaseous Effluent Dose Rate Limitation

a. **Requirement**

Dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to:

1. The dose rate limit for noble gases shall be ≤ 500 mrem/year to the total body and ≤ 3000 mrem/year to the skin.

SUPERSEDED

2. The dose rate limit for I^{131}, I^{133}, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days shall be ≤ 1500 mrem/year to the critical organ.

b. **Action**

1. If dose rates exceed Step 6.3.1.a. limits, promptly decrease the release rate to within the above limits.

2. Dose rates due to noble gases in gaseous effluents shall be determined, continuously, to be within Step 6.3.1.a. limits.

3. Dose rates due to I^{131}, I^{133}, tritium, and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents shall be determined to be within the above limits by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified on Radioactive Gaseous Waste Sampling and Analysis Program (Attachment 4).

SUPERSEDED

c. **Calculations of Gaseous Effluent Dose Rates**

1. The dose rate limit for noble gases shall be determined to be within the limit by limiting the release rate to the lesser of:

$$\sum_i [K_{ivv}\dot{Q}_{ivv} + K_{ipv}\dot{Q}_{ipv}] \leq 500 \text{mrem/yr to the total body} \quad (10)$$

OR

$$\sum_i [(L_{ivv} + 1.1M_{ivv})\dot{Q}_{ivv} + (L_{ipv} + 1.1M_{ipv})\dot{Q}_{ipv}] \leq 3000 \text{mrem/yr to the skin} \quad (11)$$

where:

Subscripts	=	vv, refers to vent releases from the building ventilation vent pv, refers to the vent releases from the process vent; i, refers to individual radionuclide
K_{ivv}, K_{ipv}	=	The total body dose factor for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide i, in mrem/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)
L_{ivv}, L_{ipv}	=	The skin dose factor for ventilation vents or process vent release due to beta emissions for each identified noble gas radionuclide i, in mrem/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)
M_{ivv}, M_{ipv}	=	The air dose factor for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide, i, in mrad/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)
$\dot{Q}_{ivv}$, $\dot{Q}_{ipv}$	=	The release rate for ventilation vents or process vent of noble gas radionuclide i, in gaseous effluents in Curie/sec (per site)
1.1	=	The unit conversion factor that converts air dose to skin dose, in mrem/mrad

SUPERSEDED

2. The dose rate limit for I^{131}, I^{133}, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days, shall be determined to be within the limit by restricting the release rate to:

$$\sum_i [P_{ivv}\dot{Q}_{ivv} + P_{ipv}\dot{Q}_{ipv}] \leq 1500 \text{mrem/yr to the critical organ} \qquad (12)$$

where:

P_{ivv}, P_{ipv} = The critical organ dose factor for ventilation vents or process vent for I^{131}, I^{133}, H^3, and all radionuclides in particulate form with half-lives greater than 8 days, for the inhalation pathway, in mrem/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)

$\dot{Q}_{ivv}\dot{Q}_{ipv}$ = The release rate for ventilation vents or process vent of I^{131}, I^{133}, H^3, and all radionuclides i, in particulate form with half-lives greater than 8 days, in gaseous effluents in Curie/sec (per site)

3. All gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of $\dot{Q}_{ivv}$.

6.3.2 **Gaseous Monitoring Instrumentation**

a. **Requirement**

1. The radioactive gaseous effluent monitoring instrumentation channels shown in Radioactive Gaseous Effluent Monitoring Instrumentation (Attachment 6) shall be operable with alarm/trip setpoints set to ensure that Step 6.3.1.a. noble gas limits are not exceeded. Alarm/trip setpoints of these channels shall be determined and adjusted in accordance with Step 6.3.2.d.

2. Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated operable by Channel Checks, Source Checks, Channel Calibrations, and Channel Operational Tests at the frequencies shown in Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements (Attachment 7).

SUPERSEDED

b. **Action**

1. If a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required by Step 6.3.2.a.1, promptly:
   - Suspend the release of radioactive gaseous effluents monitored by the affected channel **and** declare the channel inoperable

     or

   - Change the setpoint so it is acceptably conservative

2. If the number of operable channels is less than the minimum required by tables in Radioactive Gaseous Effluent Monitoring Instrumentation (Attachment 6) take the action shown in those tables.

3. Return instruments to operable status within 30 days. If unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

c. **Applicable Monitors**

Radioactive gaseous effluent monitors for which alarm/trip setpoints shall be determined are:

Release Point	Instrument Number
Process Vent	1-GW-RM-178-1
Condenser Air Ejector	1-SV-RM-121 2-SV-RM-221
Ventilation Vent A	1-VG-RM-179-1
Ventilation Vent B	1-VG-RM-180-1

SUPERSEDED

d. **Setpoint Calculations**

1. Setpoint calculations for each monitor listed in Step 6.3.2.c. shall maintain this relationship:

$$D \geq D_{pv} + D_{cae} + D_{vv} \tag{13}$$

where:

D	=	Step 6.3.1.a. dose limits that implement 10 CFR 20 for the Station, mrem/yr
D_{pv}	=	The noble gas site boundary dose rate from process vent gaseous effluent releases, mrem/yr
D_{cae}	=	The noble gas site boundary dose rate from condenser air ejector gaseous effluent releases, mrem/yr
D_{vv}	=	The noble gas site boundary dose rate from summation of Ventilation Vent A plus B gaseous effluent releases, mrem/yr

2. Setpoint values shall be determined by:

$$C_m = \frac{R_m \times 2.12\ E\text{-}03}{F_m} \tag{14}$$

where:

m	=	The release pathway, process vent (pv), ventilation vent (vv) condenser air ejector (cae)
C_m	=	The effluent concentration limit implementing Step 6.3.1.a. for the Station, µCi/ml
R_m	=	The release rate limit for pathway m determined from methodology in Step 6.3.1.c., using Xe^{133} as nuclide to be released, µCi/sec
2.12E-03	=	CFM per ml/sec
F_m	=	The maximum flow rate for pathway m, CFM

SUPERSEDED

NOTE: According to NUREG-0133, the radioactive effluent radiation monitor alarm/trip setpoints should be based on the radioactive noble gases. It is not practicable to apply instantaneous alarm/trip setpoints to integrating monitors sensitive to radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases.

6.3.3 **Noble Gas Effluent Air Dose Limit**

a. **Requirement**

1. The air dose in unrestricted areas due to noble gases released in gaseous effluents from each unit at or beyond the site boundary shall be limited to:
   - During any calendar quarter: ≤5 mrads for gamma radiation and ≤10 mrads for beta radiation
   - During any calendar year: ≤10 mrads for gamma radiation and ≤20 mrads for beta radiation

2. Cumulative dose contributions for noble gases for the current calendar quarter and current calendar year shall be determined in accordance with Step 6.3.3.c. at least once per 31 days.

b. **Action**

If the calculated air dose from radioactive noble gases in gaseous effluents exceeds any of the above limits, prepare and submit to the NRC, within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that identifies the causes for exceeding the limits and defines corrective actions that have been taken to reduce releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the limits in Step 6.3.3.a.

SUPERSEDED

c. **Noble Gas Effluent Air Dose Calculation**

Gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of $\overline{Q}_{ivv}$.

The air dose to areas at or beyond the site boundary due to noble gases shall be determined by the following:

For gamma radiation:

$$D_g = 3.17E\text{-}08 \sum_i [M_{ivv}\overline{Q}_{ivv} + M_{ipv}\overline{Q}_{ipv}] \quad (15)$$

For beta radiation:

$$D_b = 3.17E\text{-}08 \sum_i [N_{ivv}\overline{Q}_{ivv} + N_{ipv}\overline{Q}_{ipv}] \quad (16)$$

Where:

Subscripts	=	vv, refers to vent releases from the building ventilation vents, including air ejectors pv, refers to the vent releases from the process vent i, refers to individual radionuclide
D_g	=	the air dose for gamma radiation, in mrad
D_b	=	the air dose for beta radiation, in mrad
M_{ivv}, M_{ipv}	=	the air dose factors for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide i, in mrad/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)
N_{ivv}, N_{ipv}	=	the air dose factor for ventilation vents or process vent release due to beta emissions for each identified noble gas radionuclide i, in mrad/yr per Curie/sec. Factors are listed in Gaseous Effluent Dose Factors (Attachment 5)
$\overline{Q}_{ivv}$, $\overline{Q}_{ipv}$	=	the release for ventilation vents or process vent of noble gas radionuclide i, in gaseous effluents for 31 days, quarter, or year as appropriate in Curies (per site)
3.17 E-08	=	the inverse of the number of seconds in a year

SUPERSEDED

6.3.4 **I-131, 133, H-3 & Radionuclides In Particulate Form Effluent Dose Limit**

a. **Requirement**

1. Methods shall be implemented to ensure that the dose to any organ of a member of the public from I^{131}, I^{133}, tritium, and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents released from the site to unrestricted areas from each reactor unit shall be:
   - During any calendar quarter: ≤ 7.5 mrem to the critical organ
   - During any calendar year: ≤ 15 mrem to the critical organ

2. Cumulative dose contributions to a member of the public from I^{131}, I^{133}, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents released to unrestricted areas for the current calendar quarter and current calendar year shall be determined at least once per 31 days in accordance with Step 6.3.4.c.

b. **Action**

If the calculated dose from the release of I^{131}, I^{133}, tritium, and radionuclides in particulate form, with half-lives greater than 8 days, in gaseous effluents exceeds any of the above limits, prepare and submit to the NRC within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that contains the:

1. Causes for exceeding limits.
2. Corrective actions taken to reduce releases.
3. Proposed corrective actions to be taken to assure that subsequent releases will be in compliance with limits stated in Step 6.3.4.a.

SUPERSEDED

c. **Dose Calculations**

Gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of $\tilde{Q}_{ivv}$. Historical data pertaining to the volumes and radioactive concentrations of gaseous effluents released in connection to specific Station functions, such as containment purges, shall be used in the estimates as appropriate.

1. The dose to the maximum exposed member of the public, attributable to gaseous effluents at and beyond the site boundary, that contain I^{131}, I^{133}, tritium, and particulate-form radionuclides with half-lives greater than 8 days, shall be determined by:

$$D_r = 3.17E\text{-}08 \sum_i [RM_{ivv}\tilde{Q}_{ivv} + RM_{ipv}\tilde{Q}_{ipv}] \qquad (17)$$

Where:

Subscripts	=	vv, refers to vent releases from the building ventilation vents; pv, refers to the vent releases from the process vent
D_r	=	the dose to the critical organ of the maximum exposed member of the public, in mrem
RM_{ivv}, RM_{ipv}	=	the dose factor for ventilation vents or process vent release due to I^{131}, I^{133}, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days, in mrem/yr per Curie/sec. Factors are listed in Critical Organ Dose Factors (Attachment 8)
$\tilde{Q}_{ivv}$ $\tilde{Q}_{ipv}$	=	the release for ventilation vents or process vent of I^{131}, I^{133}, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days, in Curies
3.17E-08	=	the inverse of the number of seconds in a year

SUPERSEDED

SUPERSEDED

6.3.5 **Gaseous Radwaste Treatment**

Historical data pertaining to the volumes and radioactive concentrations of gaseous effluents released in connection with specific Station functions, such as containment purges, shall be used to calculate projected doses, as appropriate.

a. **Requirement**

1. The Gaseous Radwaste Treatment System and the Ventilation Exhaust Treatment System shall be used to reduce radioactive material in gaseous waste before its discharge, when projected gaseous effluent air doses due to gaseous effluent releases, from each unit to areas at and beyond the site boundary, would exceed 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation, averaged over 31 days.

2. The Ventilation Exhaust Treatment System shall be used to reduce radioactive materials in gaseous waste before its discharge, when the projected doses due to gaseous effluent releases, from each unit to areas at and beyond the site boundary, would exceed 0.3 mrem to the critical organ, averaged over 31 days.

3. Doses due to gaseous releases from the site shall be projected at least once per 31 days, based on the calculations in Step 6.3.5.c.

b. **Action**

If gaseous waste that exceeds the limits in Step 6.3.5.a. is discharged without treatment, prepare and submit to the NRC within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that includes:

1. An explanation why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability.

2. Actions taken to restore the inoperable equipment to operable status.

3. Summary description of actions taken to prevent recurrence.

c. **Projected Gamma Dose**

1. Determine D_g, the 31-day gamma air dose for the previous 31-day period, per Equation (15).

2. Estimate R_g, the ratio of the estimated volume of gaseous effluent in the current 31-day period to the volume released during the previous 31-day period.

3. Estimate F_g, the ratio of the estimated noble gas effluent activity in the current 31-day period to the noble gas effluent activity during the previous 31-day period (μCi/ml).

4. Determine PD_g, the projected 31-day gamma air dose.

$$PD_g = D_g(R_g \times F_g) \tag{18}$$

d. **Projected Beta Dose**

1. Determine D_b, the 31-day beta air dose in the previous 31 days, per Equation (16).

2. Estimate R_g and F_g as in Steps 6.3.5.c.2. and 6.3.5.c.3.

3. Determine PD_b, the projected 31-day beta air dose.

$$PD_b = D_b(R_g \times F_g) \tag{19}$$

e. **Projected Maximum Exposed Member of the Public Dose**

1. Determine D_{max}, the 31-day maximum exposed member of the public dose in the previous 31-day period, per Equation (14), where $D_r = D_{max}$.

2. Estimate F_i, the ratio of the estimated activity from I^{131}, I^{133}, radioactive materials in particulate form with half-lives greater than 8 days, and tritium in the current 31-day period to the activity of I^{131}, I^{133}, radioactive materials in particulate form with half-lives greater than 8 days, and tritium in the previous 31-day period (μCi/ml).

3. Determine PD_{max}, the projected 31-day maximum exposed member of the public dose.

$$PD_{max} = D_{max}(R_g \times F_i) \tag{20}$$

SUPERSEDED

6.4 Radioactive Liquid and Gaseous Release Permits

RP shall maintain procedures for Liquid and Gaseous Release Permits to ensure effluent dose limits are not exceeded when making releases.

6.4.1 Liquid Waste Batch Release Permits

Operations shall obtain RP authorization before initiating batch releases of radioactive liquids. Examples of batch releases include:

Batch Releases

NOTE: If the clarifier is in service, releases from tanks processed through the clarifier are considered continuous releases.

A Batch Release Permit is required for a release from any tanks/sumps which contain (or potentially contain) radioactive liquid. Tanks/sumps include:

- BRTT
- LLWDT
- HLWDT
- Turbine Building Sumps when secondary coolant activity exceeds 1.0 E-5 µCi/ml
- CDT

6.4.2 Continuous Release Permit

Operations shall obtain RP authorization before initiating continuous releases of radioactive liquids.

Continuous Releases

A Continuous Release Permit is required for:

- Clarifier, unless being bypassed
- Steam generator blowdown when clarifier is bypassed
- Containment mat sumps and service water reservoir when clarifier is bypassed. Sampling requirements and control and conditions for service water reservoir blowdown, when no radioactivity is detected, shall be specified on the permit.

SUPERSEDED

6.4.3 **Waste Gas Decay Tank (WGDT) Release Permit**

Operations shall obtain RP authorization before initiating WGDT releases.

6.4.4 **Reactor Containment Release Permits**

Operations shall obtain authorization from RP before initiating containment purges or containment hogging. Reactor Containment Release Permits shall be valid from start of purge/hog until:

- Routine termination
- Terminated for cause by RP
- Receipt of Radiation Monitoring System (RMS) Containment Gas Monitor high alarm

6.4.5 **Miscellaneous Gaseous Release Permit**

Operations shall obtain RP authorization before initiating releases of noble gases that may not be accounted for by routine sampling, or any planned release not being routed through the Process Vent or Ventilation Vents (e.g., steam driven auxiliary feedwater pump testing if primary to secondary leakage exists).

6.4.6 **Radioactive Liquid and Gaseous Release Controls**

a. Operations shall notify RP of pending releases and request RP to initiate the appropriate release permit. Operations shall provide the necessary information to complete the required release permit.

b. A representative sample shall be obtained of the source to be released.

   1. Operations shall provide RP with liquid samples and sample information (e.g., time of sample) for samples obtained outside the Primary Sample Room, except Clarifier Proportional Tank and Clarifier Grab Samples.

   2. Chemistry shall provide RP with liquid samples and sample information for samples obtained from inside the Primary Sample Room.

   3. RP shall obtain gaseous samples.

c. RP shall perform required sample analyses.

SUPERSEDED

d. RP shall calculate and record the following information on a release permit:
   - Maximum authorized release rate
   - Maximum authorized release rate in percentage of limits specified by the ODCM
   - Applicable conditions or controls pertaining to the release

e. RP shall notify the Shift Supervisor if it is determined that a release may not be within the effluent dose limits.

f. Upon receipt of a release permit from RP, Operations shall:
   1. Verify the correct source is authorized for release.
   2. Note maximum authorized release rate.
   3. Note percent of Technical Specifications limits the release represents.
   4. Note and ensure compliance with any indicated controls or conditions applicable to the release.

g. When commencing release, Operations shall provide RP with required information. As appropriate, required information shall include:
   - Date and time release was started
   - Starting tank/sump level
   - Beginning pressure
   - Release flow rate
   - Dilution water flow rate

h. Upon terminating the release, Operations shall return the permit to RP and provide information necessary for completion of permit. As appropriate, required information shall include:
   - Date and time release was stopped
   - Tank/sump ending level
   - Release flow rate just prior to termination
   - Ending pressure
   - Volume released

SUPERSEDED

6.5 Total Dose Limit to Public From Uranium Fuel Cycle Sources

6.5.1 Requirement

The annual (calendar year) dose or dose commitment to a real individual due to releases of radioactivity and radiation from uranium fuel cycle sources shall not exceed 25 mrem to the total body or the critical organ (except the thyroid, which shall not exceed 75 mrem).

6.5.2 Action

a. If the calculated doses from release of radioactive materials in liquid or gaseous effluents exceed twice the limits in Steps 6.2.3.a., 6.3.3.a., or 6.3.4.a., calculate (including direct radiation contribution from the units and from outside storage tanks) whether limits in Step 6.5.1 have been exceeded.

b. If the limits in Step 6.5.1 have been exceeded, prepare and submit to the NRC within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that defines the corrective action to be taken to reduce subsequent releases and to prevent recurrence, and includes a schedule for achieving conformance with the limits. Special reports, as defined in 10 CFR 20.2203(a)(4), shall include:

   1. An analysis that estimates the radiation exposure (dose) to a real individual from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the releases covered by the report.

   2. A description of the levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations.

   3. If the estimated dose exceeds the limits in Step 6.5.1, and if the release condition that violates 40 CFR 190 has not already been corrected, the special report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

6.6 Radiological Environmental Monitoring

6.6.1 Monitoring Program

a. **Requirement**

   1. The Radiological Environmental Monitoring Program shall be conducted as specified in Radiological Environmental Monitoring Program (Attachment 9).

SUPERSEDED

2. Samples shall be collected from specific locations specified in Environmental Sampling Locations (Attachment 10). **[Reference 3.1.31]**

3. Samples shall be analyzed in accordance with:
   - Radiological Environmental Monitoring Program (Attachment 9) requirements
   - Detection capabilities required by Detection Capabilities for Environmental Sample Analysis (Attachment 11)
   - Guidance of the Radiological Assessment Branch Technical Position on Environmental Monitoring dated November, 1979, Revision No. 1

b. **Action**

1. If the Radiological Environmental Monitoring Program is not being conducted as required in Step 6.6.1.a., report the situation in accordance with VPAP-2802, Notifications and Reports, by preparing and submitting to the NRC, in the Annual Radiological Environmental Operating Report required by Technical Specifications 5.6.2, a description of the reasons for not conducting the program as required, and the plan for precluding recurrence.

2. If, when averaged over any calendar quarter, radioactivity exceeds the reporting levels of Reporting Levels for Radioactivity Concentrations in Environmental Samples (Attachment 12) prepare and submit to the NRC within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that:
   - Identifies the causes for exceeding the limits, and
   - Defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a member of the public is less than the calendar year limits of Steps 6.2.3, 6.3.3, and 6.3.4

   When more than one of the radionuclides listed in Reporting Levels for Radioactivity Concentrations in Environmental Samples (Attachment 12) are detected in the sampling medium, the report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1.0 \qquad (21)$$

SUPERSEDED

3. When radionuclides other than those listed in Reporting Levels for Radioactivity Concentrations in Environmental Samples (Attachment 12) are detected and are the result of plant effluents, the report shall be submitted if the potential annual dose to a member of the public is equal to or greater than the calendar year limits of Steps 6.2.3, 6.3.3, and 6.3.4. The report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, report and describe the condition in the Annual Radiological Environmental Operating Report in accordance with VPAP-2802, Notifications and Reports.

4. If milk or fresh leafy vegetable samples are unavailable from one or more of the sample locations required by Environmental Sampling Locations (Attachment 10), identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Identify the cause of the unavailability of samples and identify the new locations for obtaining replacement samples in the next Annual Radioactive Effluent Release Report in accordance with VPAP-2802, Notifications and Reports. Include in the report a revised figure and table for the ODCM to reflect the new locations.

6.6.2 **Land Use Census**

a. **Requirement**

A land use census shall be conducted and shall identify, within a distance of 8 km (5 miles), the location in each of the 16 meteorological sectors of the following:

- Nearest milk animal
- Nearest residence
- Nearest garden greater than 50 m^2 (500 ft^2) that produces broad leaf vegetation

1. The land use census shall be conducted during the growing season, at least once per 12 months, using methods that will provide the best results (e.g., door-to-door survey, aerial survey, local agriculture authorities). Land use census results shall be included in the Annual Radiological Environmental Operating Report in accordance with VPAP-2802, Notifications and Reports.

SUPERSEDED

2. In lieu of the garden census, broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted ground deposition (D/Qs). Specifications for broad leaf vegetation sampling in Radiological Environmental Monitoring Program (Attachment 9) shall be followed, including analysis of control samples.

b. **Action**

1. If a land use census identifies locations that yield a calculated dose or dose commitment greater than the values currently being calculated in 6.3.4.a.2, identify the new locations in the next Annual Radioactive Effluent Release Report in accordance with VPAP-2802, Notifications and Reports.

2. If a land use census identifies locations that yield a calculated dose or dose commitment (via the same exposure pathway) 25 percent greater than at a location from which samples are currently being obtained, add the new locations to the Radiological Environmental Monitoring Program within 30 days. Sampling locations, excluding the control station location, that have the lowest calculated dose or dose commitments (via the same exposure pathway) may be deleted from the monitoring program. Identify new locations in the next Annual Radioactive Effluent Release Report and include in the report revised figures and tables reflecting the new locations in accordance with VPAP-2802, Notifications and Reports. **[Reference 3.1.33]**

6.6.3 **Interlaboratory Comparison Program**

a. **Requirement**

Radioactive materials (which contain nuclides produced at the Station), supplied as part of an Interlaboratory Comparison Program, shall be analyzed.

SUPERSEDED

b. **Action**

1. Analyses shall be performed at least semiannually as follows:

Program	Cross-Check of
Milk	I^{131}, Gamma, Sr^{89} and Sr^{90}
Water	Gross Beta, Gamma, I^{131}, H^3 (Tritium), Sr^{89} and Sr^{90} (blind - any combinations of above radionuclides)
Air Filter	Gross Beta, Gamma, Sr^{90}

2. If analyses are not performed as required by Step 6.6.3.b., report in the Annual Radiological Environmental Operating Report in accordance with VPAP-2802, Notifications and Reports, the corrective actions taken to prevent recurrence.

c. **Results**

Results shall be reported in the Annual Radiological Environmental Monitoring Report in accordance with VPAP-2802, Notifications and Reports.

6.7 Reporting Requirements

6.7.1 Annual Radiological Environmental Operating Report

Routine Radiological Environmental Operating Reports covering the operation of the units during the previous calendar year shall be submitted prior to May 1 of each year. A single submittal may be made for the Station. Radiological Environmental Operating Reports shall include:

a. Summaries, interpretations, and analysis of trends of results of radiological environmental surveillance activities for the report period, including:

- A comparison (as appropriate) with preoperational studies, operational controls, and previous environmental surveillance reports
- An assessment of the observed impacts of the plant operation on the environment
- Results of land use census per Step 6.6.2

SUPERSEDED

b. Results of analysis of radiological environmental samples and of environmental radiation measurements taken per Step 6.6.1, Monitoring Program. Results shall be summarized and tabulated in the format of the table in the Radiological Assessment Branch Technical Position on Environmental Monitoring.

   1. If some individual results are not available for inclusion with the report, the report shall be submitted, noting and explaining reasons for missing results.

   2. Missing data shall be submitted in a supplementary report as soon as possible.

c. A summary description of the radiological environmental monitoring program.

d. At least two legible maps covering sampling locations, keyed to a table giving distances and directions from the centerline of one reactor. One map shall cover stations near the site boundary; a second shall include more distant stations.

e. Results of Station participation in the Interlaboratory Comparison Program, per Step 6.6.3.

f. Discussion of deviations from the Station's environmental sampling schedule per Radiological Environmental Monitoring Program (Attachment 9).

g. Discussion of analyses in which the lower limit of detection (LLD) required by Detection Capabilities for Environmental Sample Analysis (Attachment 11) was not achievable.

h. Any sample results from any groundwater wells described in the environmental program, whether the results were required by the environmental program or not.

6.7.2 **Annual Radioactive Effluent Release Report**

a. **Requirement - Station**

Radioactive Effluent Release Reports covering operation of the units during the previous 12 months of operation shall be submitted before May 1 of each year. A single submittal may be made for the Station and should combine those sections that are common to both units. Radioactive Effluent Release Reports shall include:

1. A summary of quantities of radioactive liquid and gaseous effluents and solid waste released. Data shall be summarized on a quarterly basis following the format of Regulatory Guide 1.21, Appendix B, for liquid and gaseous effluents. Data shall be summarized on an annual basis following the format of Regulatory Guide 1.21, Appendix B, for solid waste. **[Reference 3.1.34]**

SUPERSEDED

2. An assessment of radiation doses to the maximum exposed members of the public due to the radioactive liquid and gaseous effluents released from the Station during the previous calendar year. This assessment shall be in accordance with Step 6.7.2.b.

3. A list and description of unplanned releases from the site to unrestricted areas, during the reporting period, which meet the following criteria:
   - Unplanned releases that exceeded the limits in Steps 6.2.1 and 6.3.1
   - Unplanned releases which require a Condition Report and involve the discharge of contents of the wrong Waste Gas Decay Tank or the wrong liquid radwaste release tank
   - Unplanned releases from large leaks due to unexpected valve or pipe failures that result in a quantity of release such that a 10 CFR 50.72, Immediate Notification Requirements for Operating Nuclear Power Reactors or 10 CFR 50.73, Licensee Event Report System, report is required
   - Unplanned releases as determined by Radiation Protection Supervision, which may or may not require a Condition Report

4. Major changes to radioactive liquid, gaseous, and solid waste treatment systems during the reporting period.

5. Changes to VPAP-2103N, Offsite Dose Calculation Manual (North Anna) (See Step 6.7.4).

6. A listing of new locations for dose calculations or environmental monitoring identified by the land use census (See Step 6.6.2).

7. A summary of radioactive leaks or spills meeting the following criteria:
   - An unintended spill or leak with the potential to reach groundwater, as defined in NEI 07-07, **and**
   - The spill or leak must be greater than 100 gallons in volume or the volume cannot be quantified but is estimated to be greater than 100 gallons; **or**
   - Any spill or leak, regardless of volume or activity deemed by the licensee to be reportable.

SUPERSEDED

8. Any groundwater sample results from locations not part of the Radiological Environmental Monitoring Program.

b. **Dose Assessment**

1. Radiation dose to individuals due to radioactive liquid and gaseous effluents from the Station during the previous calendar year shall either be calculated in accordance with this procedure or in accordance with Regulatory Guide 1.109. Population doses shall not be included in dose assessments.

2. The dose to the maximum exposed member of the public due to radioactive liquid and gaseous effluents from the Station shall be incorporated with the dose assessment performed above. If the dose to the maximum exposed member of the public exceeds twice the limits of 6.2.3.a.1, 6.2.3.a.2, 6.3.3.a.1, or 6.3.4.a.1, the dose assessment shall include the contribution from direct radiation.

NOTE: NUREG-0543 states: "There is reasonable assurance that sites with up to four operating reactors that have releases within Appendix I design objective values are also in conformance with the EPA Uranium Fuel Cycle Standard, 40 CFR Part 190."

3. Meteorological conditions during the previous calendar year or historical annual average atmospheric dispersion conditions shall be used to determine gaseous pathway doses.

SUPERSEDED

NOTE: The Annual Radioactive Effluent Report for the North Anna ISFSI is included as part of the North Anna Station Annual Radioactive Effluent Release Report.

c. **ISFSI**

Dose Assessment

- Radiation dose to individuals due to radioactive liquid and gaseous effluents during the previous calendar year shall either be calculated in accordance with this procedure or in accordance with Regulatory Guide 1.109. Population doses shall **not** be included in dose assessments.
- The dose to the maximum exposed member of the public due to radioactive liquid and gaseous effluents from the Station shall be incorporated with the dose assessment performed above. If the dose to the maximum exposed member of the public exceeds twice the limits of 6.2.3.a.1, 6.2.3.a.2, 6.3.3.a.1, or 6.3.4.a.1, the dose assessment shall include the contribution from direct radiation.
- Meteorological conditions during the previous calendar year or historical annual average atmospheric dispersion conditions shall be used to determine gaseous pathway doses.

6.7.3 **Annual Meteorological Data**

a. Meteorological data collected during the previous year shall be in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.

b. Meteorological data shall be retained in a file on site and shall be made available to NRC upon request.

6.7.4 **Changes to the ODCM**

Changes to the ODCM shall be:

a. Reviewed and approved by Facility Safety Review Committee (FSRC) and Site Vice President before implementation.

b. Documented. Records of reviews shall be retained as Station records. Documentation shall include:

1. Sufficient information to support changes, together with appropriate analyses or evaluations justifying changes.

SUPERSEDED

2. A determination that a change will not adversely impact the accuracy or reliability of effluent doses or setpoint calculations, and will maintain the level of radioactive effluent control required by:
   - 10 CFR 20 Subpart D
   - 40 CFR 190
   - 10 CFR 50.36a
   - 10 CFR 50, Appendix I

c. Submitted to NRC in the form of a complete, legible copy of the entire ODCM as a part of, or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

d. Submitted to NRC in accordance with VPAP-2802, Notifications and Reports.

6.7.5 **Groundwater Protection Initiative [Reference 3.1.35]**

a. **Notifications and Reports**

1. Informal communication shall be made to state/local/NRC officials by the end of the next business day for:
   - Any spill or leak meeting the requirements of Step 6.7.2.a.7.
   - Any groundwater sample result exceeding the reporting levels of Reporting Levels for Radioactivity Concentrations in Environmental Samples (Attachment 12).

2. A 30-day report shall be submitted to the NRC and a copy concurrently forwarded to state and local officials for any groundwater sampling result, whether on site or off site, exceeding the reporting levels of Reporting Levels for Radioactivity Concentrations in Environmental Samples (Attachment 12) and having the potential to reach groundwater that is or could be used as a source of drinking water. A 30-day report is only required on the initial discovery of a contaminated groundwater plume.

b. Any spill or leak for which an informal notification is made in accordance with Step 6.7.5.a. shall be summarized in the Annual Radioactive Effluent Report.

SUPERSEDED

c. Any groundwater sample result from a groundwater source that is **not** part of the radiological environmental monitoring program shall be included in the Annual Radioactive Effluent Report.

d. Any groundwater sample result from any groundwater well described in the radiological environmental monitoring program shall be included in the Annual Radiological Environmental Operating Report.

7.0 RECORDS

7.1 The following record(s) completed as a result of this procedure are required to be transmitted to Nuclear Document Management (DNM). The records have been identified and retention requirements established for the Nuclear Records Retention Schedule (NRRS) per RM-AA-100, Record Creation, Transmittal and Retrieval.

Quality Assurance Records

- Records of changes to the ODCM in accordance with Step 6.7.4
- Records of meteorological data in accordance with Step 6.7.3
- Records of sampling and analyses
- Records of radioactive materials and other effluents released to the environment
- Records of preventive maintenance, surveillances, and calibrations

7.2 The following item(s) completed as a result of this procedure are **NOT** records and are **NOT** required to be transmitted to Nuclear Document Management (DNM).

None

SUPERSEDED

ATTACHMENT 1

(Page 1 of 2)

Radioactive Liquid Effluent Monitoring Instrumentation

Instrument	Minimum Operable Channels	Action
1. **Liquid Radwaste Effluent**		
(a) 1-LW-RM-111, Liquid Radwaste Effluent Monitor	1	1
(b) 1-LW-FT-104, Liquid Radwaste Effluent Total Flow Measuring Device	1	2
(c) 1-LW-TK-20, Liquid Waste Effluent Sample Vessel	1	1
(d) 1-LW-1130, Liquid Waste Effluent Proportional Sample Valve	1	1
(e) 1-SW-RM-108, Service Water Effluent Monitor (Note 1) (Note 2)	1	1
(f) 1-SW-RM-130, Unit 1 Circulating Water System Effluent Line Monitor	1	3
(g) 2-SW-RM-230, Unit 2 Circulating Water System Effluent Line Monitor	1	3
2. **Steam Generator High Capacity Blowdown**		
(a) Steam Generator High Capacity Blowdown Radiation Monitor		
Unit 1 1-SS-RM-125	1	1
Unit 2 2-SS-RM-225	1	1
(b) Steam Generator High Capacity Blowdown Flash Tank Outlet Flow Rate		
Unit 1 1-BD-FT-105	1	2
Unit 2 2-BD-FT-205	1	2
(c) Steam Generator High Capacity Blowdown Proportional Sampling System Collection Tank		
Unit 1 1-BD-TK-4	1	1
Unit 2 2-BD-TK-4	1	1

SUPERSEDED

ATTACHMENT 1

(Page 2 of 2)

Radioactive Liquid Effluent Monitoring Instrumentation

ACTION 1: If the number of operable channels is less than required, effluent releases via this pathway may continue if, at least once within 12 hours, grab samples are collected and analyzed for gross radioactivity (beta and gamma) at an LLD of at least 1×10^{-7} µCi/g or an isotopic radioactivity at an LLD of at least 5×10^{-7} µCi/g.

ACTION 2: If the number of operable channels is less than required, effluent releases via this pathway may continue if the flow rate is estimated at least once per 4 hours during actual releases. Design capacity performance curves generated in situ may be used to estimate flow.

ACTION 3: If the number of operable channels is less than required, make repairs as soon as possible. Effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples from the discharge canal are collected and analyzed for principal gamma emitters as defined in Radioactive Liquid Waste Sampling and Analysis Program (Attachment 3).

NOTE 1: The capability for obtaining grab samples at least every 12 hours must exist. Grab samples shall commence if there is indication of radioactivity in the Service Water System or an indication from other radiation monitors in the Service Water System of an increase in radioactivity.

NOTE 2: To utilize 1-SW-RM-108 as the effluent radiation monitor for the associated loop, 0-PT-75.21, (1-SW-RM-108 Flow Verification) must be performed prior to placing the loop in service. Effluent monitoring is not required when discharge flowpath is not in service.

SUPERSEDED

ATTACHMENT 2

(Page 1 of 2)

Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

Channel Description	Channel Check	Source Check	Channel Calibration	Channel Operational Test
1. **Liquid Radwaste Effluent**				
(a) 1-LW-RM-111, Liquid Radwaste Effluent Monitor	D	D	R	Q (NOTE 1)
(b) 1-LW-FT-104, Liquid Radwaste Effluent Total Flow Measuring Device	D (NOTE 3)	N/A	R	Q
(c) 1-LW-TK-20, Liquid Waste Effluent Sample Vessel	D (NOTE 4)	N/A	N/A	N/A
(d) 1-LW-1130, Liquid Waste Effluent Proportional Sample Valve	D (NOTE 4)	N/A	N/A	N/A
(e) 1-SW-RM-108, SW Effluent Monitor (NOTE 9)	D	M	R	Q (NOTE 2)
(f) 1-SW-RM-130, Unit 1 Circulating Water System Effluent Line Monitor	D	M	R	Q (NOTE 2)
(g) 2-SW-RM-230, Unit 2 Circulating Water System Effluent Line Monitor	D	M	R	Q (NOTE 2)
2. **Steam Generator (SG) High Capacity Blowdown**				
(a) SG High Capacity Blowdown Radiation Monitor Unit 1 1-SS-RM-125 Unit 2 2-SS-RM-225	D (NOTE 7)	D (NOTE 8)	R	Q (NOTE 6) R (NOTE 5)
(b) SG High Capacity Blowdown Flash Tank Outlet Flow Rate Unit 1 1-BD-FT-105 Unit 2 2-BD-FT-205	D (NOTE 8)	N/A	R	N/A
(c) SG High Capacity Blowdown Proportional Sampling System Collection Tank Unit 1 1-BD-TK-4 Unit 2 2-BD-TK-4	D (NOTE 4)	N/A	N/A	N/A

SUPERSEDED

ATTACHMENT 2

(Page 2 of 2)

Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

NOTE 1: The Channel Operational Test shall demonstrate:

a. Automatic isolation of this pathway and Control Room alarm annunciation occur if the instrument indicates measured levels above alarm/trip setpoint.

b. Alarm annunciation occurs if the instrument controls are not set in "operate" mode.

NOTE 2: The Channel Operational Test shall demonstrate that Control Room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.

b. Instrument controls not set in "operate" mode.

NOTE 3: Channel Check shall consist of verifying indication of flow during periods of release. Channel Check shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

NOTE 4: Channel Check shall consist of verifying that proportional flow exceeds 0.5 mls/gallon.

NOTE 5: Channel Operational Test shall demonstrate that system isolation occurs on a radiation monitor High-High Alarm.

NOTE 6: Channel Operational Test shall demonstrate:

a. Trip signals are generated at the required setpoints. Isolation is not required.

b. Local radiation monitor indication occurs if instrument controls are not set in "Operate" mode or if the instrument indicates measured levels are above the alarm/trip setpoint.

NOTE 7: The radiation monitor automatically performs periodic source checks. The Source Check and Channel Check are satisfied as long as the green light is lit.

NOTE 8: This is verified by indicated effluent flow less than or equal to 190 gpm.

NOTE 9: To utilize 1-SW-RM-108 as the effluent radiation monitor for the associated loop, 0-PT-75.21, (1-SW-RM-108 Flow Verification) must be performed prior to placing the loop in service. Effluent monitoring is not required when discharge flowpath is not in service.

SUPERSEDED

ATTACHMENT 3

(Page 1 of 3)

Radioactive Liquid Waste Sampling and Analysis Program

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml), (Note 1)
Batch Releases (Notes 2 and 7)	P (Each Batch)	P (Each Batch)	Principle Gamma Emitters (Note 3)	5×10^{-7}
			I^{131}	1×10^{-6}
	P (One Batch/M)	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5} (Note 8)
	P (Each Batch)	M Composite (Note 4)	H^3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	P (Each Batch)	Q Composite (Note 4)	Sr^{89} and Sr^{90}	5×10^{-8}
			Fe^{55}	1×10^{-6}
Continuous Releases (Note 5)	Continuous (Note 6)	W Composite (Note 6)	Principal Gamma Emitters (Note 6)	5×10^{-7}
			I^{131}	1×10^{-6}
	M	Grab Sample	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5} (Note 8)
	Continuous (Note 6)	M Composite (Note 6)	H^3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Continuous (Note 6)	Q Composite (Note 6)	Sr^{89} and Sr^{90}	5×10^{-8}
			Fe^{55}	1×10^{-6}

SUPERSEDED

ATTACHMENT 3

(Page 2 of 3)

Radioactive Liquid Waste Sampling and Analysis Program

NOTE 1: For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \bullet V \bullet 2.22E{+}06 \bullet Y \bullet e^{-(\lambda \Delta t)}} \qquad (9\text{-}1)$$

Where:

LLD	=	the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (See Subsection 4.8)
s_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute, cpm)
E	=	the counting efficiency (as counts per disintegration)
V	=	the sample size (in units of mass or volume)
2.22E+06	=	the number of disintegrations per minute (dpm) per microcurie
Y	=	the fractional radiochemical yield (when applicable)
λ	=	the radioactive decay constant for the particular radionuclide
Δt	=	the elapsed time between the midpoint of sample collection and time of counting

Typical values of E, V, Y and Δt should be used in the calculation.

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not a "posteriori" (after the fact) limit for a particular measurement.

NOTE 2: A batch release is the discharge of liquid wastes of a discrete volume. Before sampling for analyses, each batch shall be isolated, and then thoroughly mixed as the situation permits, to assure representative sampling.

SUPERSEDED

ATTACHMENT 3

(Page 3 of 3)

Radioactive Liquid Waste Sampling and Analysis Program

NOTE 3: The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn^{54}, Fe^{59}, Co^{58}, Co^{60}, Zn^{65}, Mo^{99}, Cs^{134}, Cs^{137}, Ce^{141}, and Ce^{144}. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

NOTE 4: A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and for which the method of sampling employed results in a specimen that is representative of the liquids released.

NOTE 5: A continuous release is the discharge of liquid wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

NOTE 6: To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent releases.

NOTE 7: Whenever the secondary coolant activity exceeds 10^{-5} μCi/ml, the turbine building sump pumps shall be placed in manual operation and samples shall be taken and analyzed prior to release. Secondary coolant activity samples shall be collected and analyzed on a weekly basis. These samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

NOTE 8: The gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, Xe-135m and Xe-138. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides shall also be identified and reported.

SUPERSEDED

ATTACHMENT 4

(Page 1 of 4)

Radioactive Gaseous Waste Sampling and Analysis Program

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml), (Note 1)
A. Waste Gas Storage Tank	Prior to Release (Each Tank Grab Sample)	Prior to Release (Each Tank)	Principal Gamma Emitters (Note 2)	1×10^{-4}
			H^3	1×10^{-6}
B. Containment Purge	Prior to Release (Each PURGE Grab Sample)	Prior to Release (Each PURGE)	Principle Gamma Emitters (Note 2)	1×10^{-4}
			H^3	1×10^{-6}
C. Ventilation (1) Process Vent (2) Vent Vent A (3) Vent Vent B	Monthly (Grab Sample) (Notes 3, 4, and 5)	Monthly (Note 3)	Principle Gamma Emitters (Note 2)	1×10^{-4}
			H^3	1×10^{-6}
All Release Types as listed in A, B, and C	Continuous (Note 4)	Weekly (Charcoal Sample)	I^{131}	1×10^{-12}
			I^{133}	1×10^{-10}
	Continuous (Note 4)	Weekly Particulate Sample	Principal Gamma Emitter (Note 2)	1×10^{-11}
	Continuous (Note 4)	Monthly Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous (Note 4)	Quarterly Composite Particulate	Sr^{89} and Sr^{90}	1×10^{-11}
	Continuous (Note 4)	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-6}
Condenser Air Ejector/Steam Generator Blowdown Vent / BRT Vent	Weekly Grab Sample (Note 6)	Weekly	Principle Gamma Emitters (Note 7)	1×10^{-4}
			H^3	1×10^{-6}
Containment Vacuum Steam Ejector (Hogger)	Prior to Release (Grab Sample) (Note 8)	Prior to each Release	Principle Gamma Emitters (Note 2)	1×10^{-4}
			H^3	1×10^{-6}

SUPERSEDED

ATTACHMENT 4

(Page 2 of 4)

Radioactive Gaseous Waste Sampling and Analysis Program

NOTE 1: For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \bullet V \bullet 2.22E{+}06 \bullet Y \bullet e^{-(\lambda \Delta t)}} \qquad (11\text{-}1)$$

Where:

LLD	=	the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (See Subsection 4.9)
s_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute, cpm)
E	=	the counting efficiency (as counts per disintegration)
V	=	the sample size (in units of mass or volume)
2.22E+06	=	the number of disintegrations per minute (dpm) per microcurie
Y	=	the fractional radiochemical yield (when applicable)
λ	=	the radioactive decay constant for the particular radionuclide
Δt	=	the elapsed time between the midpoint of sample collection and time of counting

Typical values of E, V, Y and Δt should be used in the calculation.

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as "posteriori" (after the fact) limit for a particular measurement.

SUPERSEDED

ATTACHMENT 4

(Page 3 of 4)

Radioactive Gaseous Waste Sampling and Analysis Program

NOTE 2: The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr^{87}, Kr^{88}, Xe^{133}, Xe^{133m}, Xe^{135}, Xe^{135m}, and Xe^{138} for gaseous emissions and Mn^{54}, Fe^{59}, Co^{58}, Co^{60}, Zn^{65}, Mo^{99}, Cs^{134}, Cs^{137}, Ce^{141} and Ce^{144} for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

NOTE 3: Sampling and analysis shall also be performed following shutdown, start-up, and whenever a thermal power change exceeding 15 percent of the rated thermal power occurs within any one-hour period, if:

a. Analysis shows that the dose equivalent I^{131} concentration in the primary coolant is greater than 1.0 μCi/gm; and

b. The noble gas activity monitor shows that effluent activity has increased by more than a factor of 3.

NOTE 4: The ratio of the sample flow rate to the sampled stream flow rate shall be known for the period covered by each dose or dose rate calculation made in accordance with Steps 6.3.1, 6.3.3, and 6.3.4.

NOTE 5: Samples shall be changed at least once per seven days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling shall also be performed at least once per 24 hours for at least seven days following each shutdown, start-up or thermal power change exceeding 15 percent of rated thermal power in one hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement applies if:

a. Analysis shows that the dose equivalent I^{131} concentration in the primary coolant is greater than 1.0 μCi/gm and;

b. Noble gas monitor shows that effluent activity has increased more than a factor of 3.

SUPERSEDED

ATTACHMENT 4

(Page 4 of 4)

Radioactive Gaseous Waste Sampling and Analysis Program

NOTE 6: Whenever the secondary coolant activity exceeds 10^{-5} µCi/ml, Condenser Air Ejector and Steam Generator Blowdown Vent samples shall be obtained and analyzed weekly. Secondary coolant activity samples shall be collected and analyzed on a weekly basis. These samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

NOTE 7: The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr^{87}, Kr^{88}, Xe^{133}, Xe^{133m}, Xe^{135}, Xe^{135m}, and Xe^{138} for gaseous emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD together with the above nuclides, shall also be identified and reported.

NOTE 8: If the secondary coolant activity level in any Steam Generator supplying steam to the Hogger exceeds 1.0E-5 µCi/ml, Steam Generator samples shall be obtained and analyzed prior to release.

SUPERSEDED

ATTACHMENT 5

(Page 1 of 3)

Gaseous Effluent Dose Factors

(Gamma and Beta Dose Factors)

χ/Q = 9.3E-06 sec/m^3 at 1416 meters SE Direction

Dose Factors for Ventilation Vent

Noble Gas Radionuclide	K_{ivv} Total Body mrem/yr Curie/sec	L_{ivv} Skin mrem/yr Curie/sec	M_{ivv} Gamma Air mrad/yr Curie/sec	N_{ivv} Beta Air mrad/yr Curie/sec
Kr-85m	1.09E+04	1.36E+04	1.14E+04	1.83E+04
Kr-85	1.50E+02	1.25E+04	1.60E+02	1.81E+04
Kr-87	5.51E+04	9.05E+04	5.74E+04	9.58E+04
Kr-88	1.37E+05	2.20E+04	1.41E+05	2.72E+04
Kr-89	1.54E+05	9.39E+04	1.61E+05	9.86E+04
Xe-131m	8.51E+02	4.43E+03	1.45E+03	1.03E+04
Xe-133m	2.33E+03	9.24E+03	3.04E+03	1.38E+04
Xe-133	2.73E+03	2.85E+03	3.28E+03	9.77E+03
Xe-135m	2.90E+04	6.61E+03	3.12E+04	6.87E+03
Xe-135	1.68E+04	1.73E+04	1.79E+04	2.29E+04
Xe-137	1.32E+04	1.13E+05	1.40E+04	1.18E+05
Xe-138	8.21E+04	3.84E+04	8.57E+04	4.42E+04
Ar-41	8.22E+04	2.50E+04	8.65E+04	3.05E+04

SUPERSEDED

ATTACHMENT 5

(Page 2 of 3)

Gaseous Effluent Dose Factors

(Gamma and Beta Dose Factors)

χ/Q = 1.2E-06 sec/m^3 at 1513 meters S Direction

Dose Factors for Process Vent

Noble Gas Radionuclide	K_{ipv} Total Body mrem/yr Curie/sec	L_{ipv} Skin mrem/yr Curie/sec	M_{ipv} Gamma Air mrad/yr Curie/sec	N_{ipv} Beta Air mrad/yr Curie/sec
Kr-85m	1.40E+03	1.75E+03	1.48E+03	2.36E+03
Kr-85	1.93E+01	1.61E+03	2.06E+01	2.34E+03
Kr-87	7.10E+03	1.17E+04	7.40E+03	1.24E+04
Kr-88	1.76E+04	2.84E+03	1.82E+04	3.52E+03
Kr-89	1.99E+04	1.21E+04	2.08E+04	1.27E+04
Xe-131m	1.10E+02	5.71E+02	1.87E+02	1.33E+03
Xe-133m	3.01E+02	1.19E+03	3.92E+02	1.78E+03
Xe-133	3.53E+02	3.67E+02	4.24E+02	1.26E+03
Xe-135m	3.74E+03	8.53E+02	4.03E+03	8.87E+02
Xe-135	2.17E+03	2.23E+03	2.30E+03	2.95E+03
Xe-137	1.70E+03	1.46E+04	1.81E+03	1.52E+04
Xe-138	1.06E+04	4.96E+03	1.11E+04	5.70E+03
Ar-41	1.06E+04	3.23E+03	1.12E+04	3.94E+03

SUPERSEDED

ATTACHMENT 5

(Page 3 of 3)

Gaseous Effluent Dose Factors

(Inhalation Pathway Dose Factors)

Ventilation Vent χ/Q = 9.3E-06 sec/m^3 at 1416 meters SE Direction

Process Vent χ/Q = 1.2E-06 sec/m^3 at 1513 meters S Direction

Radionuclide	P_{ivv} mrem/yr / Curie/sec	P_{ipv} mrem/yr / Curie/sec
H-3	1.05E+04	1.35E+03
Cr-51	7.95E+02	1.02E+02
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	5.64E+04	7.28E+03
Te-129m	5.88E+04	7.59E+03
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND
I-131	1.51E+08	1.95E+07
I-133	3.58E+07	4.62E+06

ND - No data for dose factor according to Regulatory Guide 1.109, Revision 1

SUPERSEDED

ATTACHMENT 6

(Page 1 of 3)

Radioactive Gaseous Effluent Monitoring Instrumentation

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION
1. PROCESS VENT SYSTEM		
(a) Noble Gas Activity Monitor		
1-GW-RM-178-1	1 (NOTE 3)	2, 4
(b) Iodine Sampler		
1-GW-RM-178-1 Process Vent Continuous HP Sampler	1 (NOTE 3)	2, 5
(c) Particulate Sampler		
1-GW-RM-178-1 Process Vent Continuous HP Sampler	1 (NOTE 3)	2, 5
(d) Total Flow Monitor		
1-GW-FT-108	1	1
(e) Sampler Flow Rate Measuring Device		
MGPI Flow Rate Measuring Device HP Sampler Rotameter	1 (NOTE 3)	1
2. CONDENSER AIR EJECTOR SYSTEM		
(a) Gross Activity Monitor		
Unit 1 1-SV-RM-121 Unit 2 2-SV-RM-221	1	3
(b) Flow Rate Measuring Device		
Unit 1 1-SV-FI-100A 1-SV-FI-101A 1-SV-FI-100B 1-SV-FI-101B	1 (NOTE 1)	1
Unit 2 2-SV-FI-200A 2-SV-FI-201A 2-SV-FI-200B 2-SV-FI-201B	1 (NOTE 2)	1

SUPERSEDED

ATTACHMENT 6

(Page 2 of 3)

Radioactive Gaseous Effluent Monitoring Instrumentation

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION
3. VENTILATION VENT A		
(a) Noble Gas Activity Monitor		
1-VG-RM-179-1	1 (NOTE 3)	2
(b) Iodine Sampler		
1-VG-RM-179-1 Vent Vent A Continuous HP Sampler	1 (NOTE 3)	2
(c) Particulate Sampler		
1-VG-RM-179-1 Vent Vent A Continuous HP Sampler	1 (NOTE 3)	2
(d) Total Flow Monitor		
1-HV-FT-1212A	1	1
(e) Sampler Flow Rate Measuring Device		
MGPI Flow Rate Measuring Device HP Sampler Rotameter	1 (NOTE 3)	1
4. VENTILATION VENT B		
(a) Noble Gas Activity Monitor		
1-VG-RM-180-1	1 (NOTE 3)	2
(b) Iodine Sampler		
1-VG-RM-180-1 Vent Vent B Continuous HP Sampler	1 (NOTE 3)	2
(c) Particulate Sampler		
1-VG-RM-180-1 Vent Vent B Continuous HP Sampler	1 (NOTE 3)	2
(d) Total Flow Monitor		
1-HV-FT-1212B	1	1
(e) Sampler Flow Rate Measuring Device		
MGPI Flow Rate Measuring Device HP Sampler Rotameter	1 (NOTE 3)	1

SUPERSEDED

ATTACHMENT 6

(Page 3 of 3)

Radioactive Gaseous Effluent Monitoring Instrumentation

ACTION 1: If the number of operable channels is less than required, effluent releases, via this path, may continue if the flow rate is estimated at least once per four hours.

ACTION 2: If the number of operable channels is less than required, effluent releases, via this path, may continue if grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

ACTION 3: If the number of operable channels is less than required, effluent releases via this path may continue if grab samples are taken at least once per twelve (12) hours and these samples are analyzed for gross activity or gamma isotopic activity within eight (8) hours. This requirement is for effluent accountability and is distinct and separate from any requirement for primary-to-secondary leak rate determination. The need to determine the primary-to-secondary leak rate, e.g., the performance of 1/2-PT-46.3B, shall be determined in accordance with the requirements of TRM TR 3.4.5. However, the same sample may be used to fulfill both the requirements of this action and primary-to-secondary leak rate determination.

ACTION 4: If the number of operable channels is less than required, the contents of the Waste Gas Decay Tanks may be released to the environment provided that prior to initiation of the release:

a. At least two independent samples of the tank's contents are analyzed, and:

b. At least two technically qualified members of the Station staff independently verify the release rate calculations and discharge valve lineup.

ACTION 5: If the number of operable channels is less than required, effluent releases from the Waste Gas Decay Tank may continue provided samples are continuously collected with auxiliary sampling equipment as required in Radioactive Gaseous Waste Sampling and Analysis Program (Attachment 4).

NOTE 1: A channel shall consist of:

a. The flow instrument installed in the ejector through which the discharge is routed; either Train A (1-SV-FI-100A, 101A), or Train B (1-SV-FI-100B, 101B) or both.

b. Flow instruments 101A and 101B provide low range measurement. Flow instruments 100A and 100B provide high range measurement.

NOTE 2: A channel shall consist of:

a. The flow instrument installed in the ejector through which the discharge is routed; either Train A (2-SV-FI-200A, 201A), or Train B (2-SV-FI-200B, 201B) or both.

b. Flow instruments 201A and 201B provide low range measurement. Flow instruments 200A and 200B provide high range measurement.

NOTE 3: A channel shall consist of a MGPI monitor; and a MGPI or HP particulate and iodine sampler, and its associated sampler flow rate measuring device or rotameter.

SUPERSEDED

ATTACHMENT 7

(Page 1 of 3)

Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	Channel Operational Test
1. PROCESS VENT SYSTEM				
(a) Noble Gas Activity Monitor				
1-GW-RM-178-1	D	M (NOTE 5)	R	Q (NOTE 1)
(b) Iodine Sampler				
1-GW-RM-178-1	W	N/A	N/A	N/A
Process Vent Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(c) Particulate Sampler				
1-GW-RM-178-1	W	N/A	N/A	N/A
Process Vent Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(d) Total Flow Monitor				
1-GW-FT-108	D	N/A	R	Q
(e) Sampler Flow Rate Measuring Device				
MGPI Flow Rate Measuring Device	D (NOTE 3)	N/A	R	N/A
HP Sampler Rotameter	D (NOTE 3)	N/A	R	N/A
2. CONDENSER AIR EJECTOR SYSTEM				
(a) Noble Gas Activity Monitor				
Unit 1 1-SV-RM-121 Unit 2 2-SV-RM-221	D	M	R	Q, R (NOTE 6)
(b) Flow Rate Measuring Device				
Unit 1 1-SV-FI-100A 1-SV-FI-101A 1-SV-FI-100B 1-SV-FI-101B	D	N/A	R	N/A
Unit 2 2-SV-FI-200A 2-SV-FI-201A 2-SV-FI-200B 2-SV-FI-201B	D	N/A	R	N/A

SUPERSEDED

ATTACHMENT 7

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Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	Channel Operational Test
3. VENTILATION VENT A				
(a) Noble Gas Activity Monitor				
1-VG-RM-179-1	D	M (NOTE 5)	R	Q (NOTE 2)
(b) Iodine Sampler				
1-VG-RM-179-1	W	N/A	N/A	N/A
Vent Vent A Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(c) Particulate Sampler				
1-VG-RM-179-1	W	N/A	N/A	N/A
Vent Vent A Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(d) Total Flow Monitor				
1-HV-FT-1212A	D	N/A	R	Q
(e) Sampler Flow Rate Measuring Device				
MGPI Flow Rate Measuring Device	D (NOTE 3)	N/A	R	N/A
HP Sampler Rotameter	D (NOTE 3)	N/A	R	N/A
4. VENTILATION VENT B				
(a) Noble Gas Activity Monitor				
1-VG-RM-180-1	D	M (NOTE 5)	R	Q (NOTE 2)
(b) Iodine Sampler				
1-VG-RM-180-1	W	N/A	N/A	N/A
Vent Vent B Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(c) Particulate Sampler				
1-VG-RM-180-1	W	N/A	N/A	N/A
Vent Vent B Continuous HP Sampler	D (NOTE 3)	N/A	N/A	N/A
(d) Total Flow Monitor				
1-HV-FT-1212B	D	N/A	R	Q
(e) Sampler Flow Rate Measuring Device				
MGPI Flow Rate Measuring Device	D (NOTE 3)	N/A	R	N/A
HP Sampler Rotameter	D (NOTE 3)	N/A	R	N/A

SUPERSEDED

ATTACHMENT 7

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Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

NOTE 1: The Channel Operational Test shall demonstrate:

a. Automatic actuation of the valves in this pathway and Control Room alarm annunciation occur if the instrument indicates measured levels above the alarm/trip setpoint.

b. Alarm annunciation occurs if the instrument controls not set in "operate" mode.

NOTE 2: The Channel Operational Test shall demonstrate:

a. Control Room alarm annunciation occurs if the instrument indicates measured levels are above the alarm/trip setpoint.

b. Alarm annunciation occurs if the instrument controls not set in "operate" mode.

NOTE 3: Channel Checks shall consist of verifying indication of flow during periods of release. Channel Checks shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made. Verification need only to be done to verify operability of one train, either MGPI or HP Sampler.

NOTE 4: The Channel Operational Test shall demonstrate that:

a. Control Room alarm annunciation occurs if the instrument indicates measured levels are above alarm/trip setpoint.

b. The Instrument mode selection control automatically resets to "operate" mode when released.

NOTE 5: Monitors 1-GW-RM-178-1, 1-VG-RM-179-1, and 1-VG-RM-180-1 perform periodic source checks automatically.

NOTE 6: The quarterly, Q, Channel Operational Test shall demonstrate that Control Room Alarm annuciation occurs if the instrument indicates measured levels above the alarm/trip setpoint **and** alarm annunciation occurs if the instrument controls are not set in the "operate" mode. The refueling, R, Channel Operational Test shall demonstrate:

a. Automatic actuation of the valves in this pathway and Control Room Alarm annunciation occur if the instrument indicates above the alarm/trip setpoint.

b. Alarm annunciation occurs if the instrument controls are not set in the "operate" mode.

SUPERSEDED

ATTACHMENT 8

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Critical Organ Dose Factors

(Critical Pathway Dose Factors)
Ventilation Vent X/Q = 3.3E-6 at 1593 meters SSE Direction
Process Vent X/Q = 9.5E-7 at 1593 meters SSE Direction
Ventilation Vent D/Q = 1.7E-8 at 1593 meters SSE Direction
Process Vent D/Q = 1.1E-8 at 1593 meters SSE Direction

Radionuclide	RM_{ivv} mrem/yr / Curie/sec	RM_{ipv} mrem/yr / Curie/sec
H-3	1.32E+4	4.28E+3
Mn-54	ND	ND
Fe-59	ND	ND
Cr-51	1.11E+3	7.16E+2
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-89	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	5.37E+6	3.48E+6
Te-129m	4.61E+6	2.98E+6
I-131	8.08E+8	5.23E+8
I-133	1.38E+7	8.93E+6
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND

SUPERSEDED

ATTACHMENT 8

(Page 2 of 2)

Critical Organ Dose Factors

Radionuclide	RM_{ivv} mrem/yr / Curie/sec	RM_{ipv} mrem/yr / Curie/sec
Ce-144	ND	ND

ND - No data for dose factor according to Regulatory Guide 1.109, Revision 1

SUPERSEDED

ATTACHMENT 9

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Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	**Number of Sample and Sample Location** (NOTE 2)	**Collection Frequency**	**Type and Frequency of Analysis**
1. DIRECT RADIATION (NOTE 3)	36 routine monitoring stations, either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, to be placed as follows: 1) An inner ring of stations, one in each emergency meteorological sector within the site boundary 2) An outer ring of stations, one in each emergency meteorological sector within 8 km range from the site 3) The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations	Quarterly	GAMMA DOSE Quarterly

SUPERSEDED

ATTACHMENT 9

(Page 2 of 5)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample and Sample Location (NOTE 2)	Collection Frequency	Type and Frequency of Analysis
2. AIRBORNE			
Radioiodines and Particulates	Samples from 5 locations: a) 3 samples from close to the 3 site boundary locations (in different sectors) of the highest calculated historical annual average ground level D/Q b) 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q c) 1 sample from a control location 15-40 km distant and in the least prevalent wind direction	Continuous sampler, operation with sample collection weekly	Radioiodine Canister I^{131} Analysis, weekly Particulate Sampler Gross beta radioactivity analysis following filter change; (NOTE 4) Gamma isotopic analysis of composite (by location) quarterly (NOTE 5)
3. WATERBORNE			
a) Surface	Samples from 3 locations: a) 1 sample upstream b) 1 sample downstream c) 1 sample from cooling lagoon	Grab Monthly	Gamma isotopic analysis monthly; (NOTE 5) Composite for tritium analysis quarterly
b) Ground	Sample from 1 or 2 sources only if likely to be affected	Grab Quarterly	Gamma isotopic and tritium analysis quarterly (NOTE 5)
c) Sediment	1 sample from downstream area with existing or potential recreational value	Semi-Annually	Gamma isotopic analysis semi-annually (NOTE 5)

SUPERSEDED

ATTACHMENT 9

(Page 3 of 5)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample and Sample Location (NOTE 2)	Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a) Milk (NOTE 7)	a) Samples from milking animals in 3 locations within 5 km that have the highest potential. If there are none, then 1 sample from milking animals in each of 3 areas between 5 to 8 km where doses are calculated to be greater than 1 mrem per yr (NOTE 6) b) 1 sample from milking animals at a control location (15-30 km in the least prevalent wind direction)	Monthly at all times	Gamma isotopic (NOTE 5) and I^{131} analysis monthly
b) Fish and Invertebrates	a) 1 sample of commercially and recreationally important species (bass, sunfish, catfish) in vicinity of plant discharge area b) 1 sample of same species in areas not influenced by plant discharge	Semiannually	Gamma isotopic on edible portions
c) Food Products	a) Samples of an edible broad leaf vegetation grown nearest each of two different offsite locations of highest predicted historical annual average ground level D/Q if milk sampling is not performed b) 1 sample of broad leaf vegetation grown 15-30 km in the least prevalent wind direction if milk sampling is not performed	Monthly if available, or at harvest	Gamma isotopic (NOTE 5) and I^{131} analysis

SUPERSEDED

ATTACHMENT 9

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Radiological Environmental Monitoring Program

NOTE 1: The number, media, frequency, and location of samples may vary from site to site. This table presents an acceptable minimum program for a site at which each entry is applicable. Local site characteristics must be examined to determine if pathways not covered by this table may significantly contribute to an individual's dose and be included in the sampling program.

NOTE 2: For each and every sample location in Environmental Sampling Locations (Attachment 10), specific parameters of distance and direction sector from the centerline of the reactor, and additional description where pertinent, shall be provided in Attachment 10. Refer to Radiological Assessment Branch Technical Positions and to NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plant. Deviations are permitted from the required sampling schedule if specimens are unattainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unattainable due to sampling equipment malfunction, every effort shall be made to complete corrective action before the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Step 6.7.1. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. In lieu of a Licensee Event Report and pursuant to Step 6.7.2, identify the cause of the unavailability of samples for that pathway and identify the new locations for obtaining replacement samples in the next Annual Radioactive Effluent Release Report, and include revised figures and tables from the ODCM reflecting the new locations in the report.

SUPERSEDED

ATTACHMENT 9

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Radiological Environmental Monitoring Program

NOTE 3: One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 36 stations are not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations, e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

NOTE 4: Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

NOTE 5: Gamma isotopic analysis is the identification and quantification of gamma-emitting radionuclides that may be attributable to effluents from the facility.

NOTE 6: The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

NOTE 7: If milk sampling cannot be performed, use item 4.c (Page 3 of 5, Radiological Environmental Monitoring Program (Attachment 9)).

SUPERSEDED

ATTACHMENT 10

(Page 1 of 4)

Environmental Sampling Locations

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	Remarks
Environmental TLDs	NAPS Sewage Treatment Plant	01	0.20	NE	Quarterly & Annually	On-Site
	Frederick's Hall	02	5.30	SSW	Quarterly & Annually	
	Mineral,VA	03	7.10	WSW	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	Quarterly & Annually	
	Route 752	05	4.20	NNE	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	2.04	N	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	Quarterly & Annually	
	Bumpass, VA	07	7.30	SSE	Quarterly & Annually	
	End of Route 685	21	1.00	WNW	Quarterly & Annually	Site Boundary
	Route 700	22	1.00	WSW	Quarterly & Annually	Site Boundary
	"Aspen Hills"	23	0.93	SSE	Quarterly & Annually	Site Boundary
	Orange, VA	24	22.00	NW	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	Quarterly	On-Site
	Sturgeon's Creek Marina	N-2/34	2.04	N	Quarterly	
	Parking Lot "C"	NNE-3/35	0.24	NNE	Quarterly	On-Site
	Good Hope Church	NNE-4/36	3.77	NNE	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	Quarterly	On-Site
	Bogg's Drive	NE-6/38	1.46	NE	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	Quarterly	On-Site
	Route 689	ENE-8/40	2.43	ENE	Quarterly	
	Near Training Facility	E-9/41	0.30	E	Quarterly	On-Site
	"Morning Glory Hill"	E-10/42	2.85	E	Quarterly	
	Island Dike	ESE-11/43	0.12	ESE	Quarterly	On-Site
	Route 622	ESE-12/44	4.70	ESE	Quarterly	

SUPERSEDED

ATTACHMENT 10

(Page 2 of 4)

Environmental Sampling Locations

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	Remarks
Environmental TLDs	Biology Lab	SE-13/45	0.64	SE	Quarterly	On-Site
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	Quarterly	Site Boundary
	Elk Creek	SSE-16/48	2.33	SSE	Quarterly	
	NAPS Access Road	S-17/49	0.47	S	Quarterly	On-Site
	Elk Creek Church	S-18/50	1.55	S	Quarterly	
	NAPS Access Road	SSW-19/51	0.42	SSW	Quarterly	On-Site
	Route 618	SSW-20/52	5.30	SSW	Quarterly	
	500KV Tower	SW-21/53	0.60	SW	Quarterly	On-Site
	Route 700	SW-22/54	3.96	SW	Quarterly	
	NAPS Radio Tower	WSW-23/55	0.38	WSW	Quarterly	On-Site
	Route 700	WSW-24/56	1.00	WSW	Quarterly	Site Boundary
	South Gate of Switchyard	W-25/57	0.32	W	Quarterly	On-Site
	Route 685	W-26/58	1.55	W	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	Quarterly	Site Boundary
	Route 685	WNW-28/60	1.40	WNW	Quarterly	
	Laydown Area North Gate	NW-29/61	0.45	NW	Quarterly	On-Site
	Lake Anna Campground	NW-30/62	2.54	NW	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	Quarterly	On-Site
	Route 208	NNW-32/64	2.21	NNW	Quarterly	
	Bumpass Post Office	C-1/2	7.30	SSE	Quarterly	
	Orange, VA	C-3/4	22.00	NW	Quarterly	Control
	Mineral, VA	C-5/6	7.10	WSW	Quarterly	
	Louisa, VA	C-7/8	11.54	WSW	Quarterly	Control

SUPERSEDED

ATTACHMENT 10

(Page 3 of 4)

Environmental Sampling Locations

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	Remarks
Airborne Particulate and Radioiodine	NAPS Sewage Treatment Plant	01	0.20	NE	Weekly	On-Site
	Biology Lab	01-A	0.64	SE	Weekly	On-Site
	Frederick's Hall	02	5.30	SSW	Weekly	
	Mineral, VA	03	7.10	WSW	Weekly	
	Wares Crossroads	04	5.10	WNW	Weekly	
	Route 752	05	4.20	NNE	Weekly	
	Sturgeon's Creek Marina	05A	2.04	N	Weekly	
	Levy, VA	06	4.70	ESE	Weekly	
	Bumpass, VA	07	7.30	SSE	Weekly	
	End of Route 685	21	1.00	WNW	Weekly	Site Boundary
	Route 700	22	1.00	WSW	Weekly	Site Boundary
	"Aspen Hills"	23	0.93	SSE	Weekly	Site Boundary
	Orange, VA	24	22.00	NW	Weekly	Control
Surface Water **[Reference 3.1.31]**	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	Monthly	
	North Anna River (upstream) Rt 669 Bridge (Brook's Bridge)	09A	12.9	WNW	Monthly	Control
	North Anna River (downstream)	11	5.80	SE	Monthly	
Groundwater (well water)	Biology Lab	01A	0.64	SE	Quarterly	
Aquatic Sediment	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	Semi-Annually	
	North Anna River (upstream) Rt 669 Bridge (Brook's Bridge)	09A	12.9	WNW	Semi-Annually	Control
	North Anna River (downstream)	11	5.80	SE	Semi-Annually	
Shoreline Soil	Lake Anna	08	3.37	SSE	Semi-Annually	
Soil	NAPS Sewage Treatment Plant	01	0.20	NE	Once per 3 yrs	On-Site

SUPERSEDED

ATTACHMENT 10

(Page 4 of 4)

Environmental Sampling Locations

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	Remarks
Soil (continued)	Fredericks Hall	02	5.30	SSW	Once per 3 yrs	
	Mineral, VA	03	7.10	WSW	Once per 3 yrs	
	Wares Crossroads	04	5.10	WNW	Once per 3 yrs	
	Route 752	05	4.20	NNE	Once per 3 yrs	
	Sturgeon's Creek Marina	05A	2.04	N	Once per 3 yrs	
	Levy, VA	06	4.70	ESE	Once per 3 yrs	
	Bumpass, VA	07	7.30	SSE	Once per 3 yrs	
	End of Route 685	21	1.00	WNW	Once per 3 yrs	Site Boundary
	Route 700	22	1.00	WSW	Once per 3 yrs	Site Boundary
	"Aspen Hills"	23	0.93	SSE	Once per 3 yrs	Site Boundary
	Orange, VA	24	22.00	NW	Once per 3 yrs	Control
Milk	Lakeside Dairy (Charles Harris)	12A	7.50	NW	Monthly	
Fish	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	Semi-Annually	
	Lake Orange	25	16.50	NW	Semi-Annually	Control
Food Products (Edible broadleaf vegetation[a])	Moody Lane	14A	varies	ESE	Monthly if available, or at harvest	
	Route 614	15	varies	SE		
	Route 629/522	16	varies	NW		Control
	Historic Ln	26	varies	S		
	"Aspen Hills" Area	23	varies	SSE		

a. If edible broadleaf vegetation is unavailable, non-edible vegetation of similar leaf characteristics may be substituted.

SUPERSEDED

ATTACHMENT 11

(Page 1 of 2)

Detection Capabilities for Environmental Sample Analysis

LOWER LIMIT OF DETECTION (LLD)

Analysis (NOTE 2)	**Water (pCi/l)**	**Airborne Particulate or Gases (pCi/m^3)**	**Fish (pCi/kg) (wet)**	**Milk (pCi/l)**	**Food Products (pCi/kg) (wet)**	**Sediment (pCi/kg) (dry)**
Gross beta	4	0.01				
H-3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	(NOTE 3) 1	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

NOTE 1: Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

NOTE 2: This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

NOTE 3: LLD for the ground (drinking) water samples. The LLD for the surface (non-drinking) water samples is 10 pCi/l.

SUPERSEDED

ATTACHMENT 11

(Page 2 of 2)

Detection Capabilities for Environmental Sample Analysis

LOWER LIMIT OF DETECTION (LLD) (NOTE 3)

NOTE 1: For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \bullet V \bullet 2.22E{+}06 \bullet Y \bullet e^{-(\lambda \Delta t)}} \qquad (25\text{-}1)$$

Where:

LLD	=	the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (See Subsection 4.9)
s_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute, cpm)
E	=	the counting efficiency (as counts per disintegration)
V	=	the sample size (in units of mass or volume)
2.22E+06	=	the number of disintegrations per minute (dpm) per microcurie
Y	=	the fractional radiochemical yield (when applicable)
λ	=	the radioactive decay constant for the particular radionuclide
Δt	=	the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples)

Typical values of E, V, Y and Δt should be used in the calculation.

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not a "posteriori" (after the fact) limit for a particular measurement.

SUPERSEDED

ATTACHMENT 12

(Page 1 of 1)

Reporting Levels for Radioactivity Concentrations in Environmental Samples

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	(NOTE 1) 20,000	-			
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

NOTE 1: For drinking water samples

SUPERSEDED

ATTACHMENT 13

(Page 1 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

1.0 METEOROLOGICAL ANALYSIS

1.1 Purpose

The purpose of the meteorological analysis was to determine the annual average χ/Q and D/Q values at critical locations around the Station for ventilation vent (ground level) and process vent (mixed mode) releases. The annual average χ/Q and D/Q values were used to perform a dose pathway analysis to determine both the maximum exposed individual at site boundary and member of the public. The χ/Q and D/Q values resulting in the maximum exposures were incorporated into the dose factors in Gaseous Effluent Dose Factors (Attachment 5) and Critical Organ Dose Factors (Attachment 8).

1.2 Meteorological Data, Parameters, and Methodology

Onsite meteorological data for the period January 1, 1981, through December 31, 1981, were used in calculations. These data included wind speed, wind direction, and differential temperature for the purpose of determining joint frequency distributions for those releases characterized as ground level (e.g., ventilation vent), and those characterized as mixed mode (i.e., process vent). The portions of release characterized as ground level were based on $\Delta T_{158.9ft-28.2ft}$ and 28.2 foot wind data, and the portions characterized as mixed mode were based on $\Delta T_{158.9ft-28.2ft}$ and 158.9 ft wind data.

χ/Q's and D/Q's were calculated using the NRC computer code "XOQDOQ - Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," September, 1977. The code is based upon a straight line airflow model implementing the assumptions outlined in Section C (excluding C1a and C1b) of Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."

The open terrain adjustment factors were applied to the χ/Q values as recommended in Regulatory Guide 1.111. The site region is characterized by gently rolling terrain so open terrain correction factors were considered appropriate. The ground level ventilation vent release calculations included a building wake correction based on a 1516 m^2 containment minimum cross-sectional area.

SUPERSEDED

ATTACHMENT 13

(Page 2 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

The effective release height used in mixed mode release calculations was based on a process vent release height of 157.5 ft, and plume rise due to momentum for a vent diameter of 3 in. with plume exit velocity of 100 ft/sec. Ventilation vent, and vent releases other than from the process vent, are considered ground level as specified in Regulatory Guide 1.111 for release points less than the height of adjacent solid structures. Terrain elevations were obtained from North Anna Power Station Units 1 and 2, Virginia Electric and Power Company Final Safety Analysis Report Table 11C.2-8.

χ/Q and D/Q values were calculated for the nearest site boundary, resident, milk cow, and vegetable garden by sector for process vent and ventilation vent releases at distances specified from North Anna Power Station Annual Environmental Survey Data for 1981. χ/Q values were also calculated for the nearest lake shoreline by sector for the process vent and ventilation vent releases.

According to the definition for short term in NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Stations," October, 1978, some gaseous releases may fit this category, primarily waste gas decay tank releases and containment purges. However, these releases are considered long term for dose calculations as past releases were both random in time of day and duration as evidenced by reviewing past release reports. Therefore, the use of annual average concentrations is appropriate according to NUREG-0133.

The χ/Q and D/Q values calculated from 1981 meteorological data are comparable to the values presented in the North Anna Power Station UFSAR.

1.3 Results

The χ/Q value that resulted in the maximum total body, skin and inhalation exposure for ventilation vent releases was 9.3E-06 sec/m^3 at a site boundary location 1416 meters SE sector. For process vent releases, the site boundary χ/Q value was 1.2E-06 sec/m^3 at a location 1513 meters S sector. The shoreline χ/Q value that resulted in the maximum inhalation exposure for ventilation vent releases was 1.0E-04 sec/m^3 at a location 274 meters NNE sector. The shoreline χ/Q value for process vent was 2.7E-06 sec/m^3 at a location 274 meters NNE sector.

SUPERSEDED

ATTACHMENT 13

(Page 3 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

The original pathway analysis indicated that the maximum exposure from I^{131}, I^{133}, and from all radionuclides in particulate form with half-lives greater than 8 days was through the grass-cow-milk pathway. The D/Q value from ventilation vent releases resulting in the maximum exposure was 2.4E-09 per m^2 at a location 3250 meters N sector. For process vent releases, the D/Q value was 1.1E-09 per m^2 at a location 3250 meters N sector. For tritium, the χ/Q value from ventilation vent releases resulting in the maximum exposure for the milk pathway was 7.2E-07 sec/m^3, and 3.9E-07 sec/m^3 for process vent releases at a location 3250 meters N sector.

Analysis using 2007 release data indicates that the most limiting critical organ is the child's thyroid. The location is 1593 meters SSE sector. For process vent releases, the D/Q is 1.1E-8. For tritium releases, the X/Q values at this location are 9.5E-7 for the process vent and 3.3E-6 for the ventilation vents.

2.0 LIQUID PATHWAY ANALYSIS

2.1 Purpose

The purpose of the liquid pathway analysis was to determine the maximum exposed member of the public in unrestricted areas as a result of radioactive liquid effluent releases. The analysis includes a determination of most restrictive liquid pathway, most restrictive age group, and critical organ. This analysis is required for Subsection 6.2.

2.2 Data, Parameters, and Methodology

Initially, radioactive liquid effluent release data for the years 1979, 1980, and 1981 were compiled from the North Anna Power Station semi-annual effluent release reports. The data for each year, along with appropriate site specific parameters and default selected parameters, were entered into the NRC computer code LADTAP as described in NUREG-0133.

SUPERSEDED

ATTACHMENT 13

(Page 4 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

Re-concentration of effluents using the small lake connected to larger water body model was selected with the appropriate parameters determined from Table 3.5.3.5, Design Data for Reservoir and Waste Heat Treatment Facility from Virginia Electric and Power Company, Applicant's Environmental Report Supplement, North Anna Power Station, Units 1 and 2, March 15, 1972. Dilution factors for aquatic foods, shoreline, and drinking water were set to one. Transit time calculations were based on average flow rates. All other parameters were defaults selected by the LADTAP computer code.

Beginning in 1997, the activity by nuclide released in the previous year is entered into the North Anna Power Station liquid pathway critical organ calculations spreadsheet, which calculates the most limiting age group total body and critical organ. This Process is repeated annually.

2.3 Results

Initially, the fish pathway resulted in the largest dose. The critical organ each year was the liver, and the adult and teenage age groups received the same organ dose. However, since the adult total body dose was greater than the teen total body dose for each year, the adult was selected as the most restrictive age group. Beginning in 1997, the most limiting age group for both total body and critical organ is calculated from the spreadsheet for North Anna Power Station liquid pathway critical organ calculations.

SUPERSEDED

ATTACHMENT 13

(Page 5 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

3.0 GASEOUS PATHWAY ANALYSIS

3.1 Purpose

A gaseous effluent pathway analysis was performed to determine the location that would result in the maximum doses due to noble gases for use in demonstrating compliance with Steps 6.3.1.a. and 6.3.3.a. The analysis also included a determination of the critical pathway, location of maximum exposed member of the public, and the critical organ for the maximum dose due to I^{131}, I^{133}, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for use in demonstrating compliance with requirements in Step 6.3.4.a.1. In addition, the analysis included a determination of the critical pathway, maximum age group, and sector location of an exposed individual through the inhalation pathway from I^{131}, I^{133}, tritium, and particulates with half-lives greater than 8 days to demonstrate compliance with Step 6.3.1.a.

3.2 Data, Parameters, and Methodology

Annual average χ/Q values were calculated, as described in Section 1 of this attachment, for the nearest site boundary in each directional sector and at other critical locations beyond the site boundary. The largest χ/Q value was determined to be 9.3E-06 sec/m^3 at site boundary for ventilation vent releases at a location 1416 meters SE direction, and 1.2E-06 sec/m^3 at site boundary for process vent releases at a location 1513 meters S direction. The maximum doses to total body and skin, and air doses for gamma and beta radiation due to noble gases, would be at these site boundary locations. The doses from both release points are summed in calculations to calculate total maximum dose.

Step 6.3.1.a.2 dose limits apply specifically to the inhalation pathway. Therefore, the locations and χ/Q values determined for maximum noble gas doses can be used to determine the maximum dose from I^{131}, I^{133}, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for the inhalation pathway.

SUPERSEDED

ATTACHMENT 13

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Meteorological, Liquid, and Gaseous Pathway Analysis

The NRC computer code GASPAR, "Evaluation of Atmospheric Releases," Revised 8/19/77, was run using 1979, 1980 and 1981 North Anna Power Station Gaseous Effluent Release Report data. Doses from I^{131}, I^{133}, tritium, and particulates for the inhalation pathway were calculated using the 9.3E-06 sec/m^3 site boundary χ/Q. Except for the source term data and the χ/Q value, computer code default parameters were used. Results for each year indicated that the critical age group was the child and the critical organ was the thyroid for the inhalation pathway.

The gamma and beta dose factors K_{ivv}, L_{ivv}, M_{ivv}, and N_{ivv} in Gaseous Effluent Dose Factors (Attachment 5) were obtained by performing a units conversion of the appropriate dose factors from Table B-1, Regulatory Guide 1.109, Rev. 1, to mrem/yr per Ci/m^3 or mrad/yr per Ci/m^3, and multiplying by the ventilation vent site boundary χ/Q value of 9.3E-06 sec/m^3. The same approach was used in calculating the gamma and beta dose factors K_{ipv}, L_{ipv}, M_{ipv}, and N_{ipv} in Gaseous Effluent Dose Factors (Attachment 5) using the process vent site boundary χ/Q value of 1.2E-06 sec/m^3.

The inhalation pathway dose factors P_{ivv} and P_{ipv} in Gaseous Effluent Dose Factors (Attachment 5) were calculated using the following equation:

$$P_i = K'(BR)\ DFA_i(\chi/Q)\ \text{(mrem/yr per Curie/sec)} \qquad (29\text{-}1)$$

where:

K' = a constant of unit conversion, 1E+12 pCi/Ci

BR = the breathing rate of the child age group, 3700 m^3/yr, from Table E-5, Regulatory Guide 1.109, Rev.1

DFA_i = the thyroid organ inhalation dose factor for child age group for the ith radionuclide, in mrem/pCi, from Table E-9, Regulatory Guide 1.109, Rev. 1

χ/Q = the ventilation vent site boundary χ/Q, 9.3E-06 sec/m^3, or the process vent site boundary χ/Q, 1.2E-06 sec/m^3, as appropriate

SUPERSEDED

ATTACHMENT 13

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Meteorological, Liquid, and Gaseous Pathway Analysis

Step 6.3.4.a., requires that the dose to the maximum exposed member of the public from I^{131}, I^{133}, tritium, and from all radionuclides in particulate form with half-lives greater than 8 days be less than or equal to the specified limits. Dose calculations were performed for an exposed member of the public within site boundary unrestricted areas, and to an exposed member of the public beyond site boundary at locations identified in the North Anna Power Station Annual Environmental Survey Data for 1981.

It was determined that the member of the public within site boundary would be using Lake Anna for recreational purposes a maximum of 2232 hours per year. It is assumed that this member of the public would be located the entire 2232 hours at the lake shoreline with the largest annual χ/Q of 1.0E-04 at a location 274 meters NNE sector. The NRC computer code GASPAR was run to calculate the inhalation dose to this individual. The GASPAR results were corrected for the fractional year the member of the public would be using the lake.

Using the NRC computer code GASPAR and annual average χ/Q and D/Q values obtained as described in Section 1 of this attachment, the member of the public receiving the largest dose beyond site boundary was determined to be located 1432 meters N sector. The critical pathway was vegetation, the maximum exposed age group was the child, and the critical organ was the thyroid.

Pathway analysis results indicate that existing pathways, including ground and inhalation, within five miles of North Anna Power Station, yield R_i dose factors less than those determined for the vegetation. **[Reference 3.1.32]**

The RM_{ivv} and RM_{ipv} dose factors, except for tritium, in Critical Organ Dose Factors (Attachment 8) were calculated by multiplying the appropriate D/Q value with the following equation:

$$RM_i = K' \left[\frac{(r)}{Yv(\lambda_i + \lambda_w)}\right](DFL_i)\left[U_{cl}F_L e^{-\lambda_i t_L} + U_a^s f_g e^{-\lambda_i t_h}\right] \qquad (29\text{-}2)$$

where:

K' = a constant of unit conversion, 1E+12 pCi/Ci

Y_v = vegetable areal density in Kg/m^2

SUPERSEDED

ATTACHMENT 13

(Page 8 of 8)

Meteorological, Liquid, and Gaseous Pathway Analysis

U_{cl} = child leafy vegetable consumption rate, 26 Kg/yr

U_{cs} = child stored vegetable consumption rate, 520 Kg/yr

r = fraction of deposited activity retained on vegetation, 1.0 for radioiodine, and 0.2 for particulates

DFL_i = thyroid ingestion dose factor for the ith radionuclide for the child, in mrem/pCi, from Table E-13, Regulatory Guide 1.109, Rev. 1

λ_i = decay constant for the ith radionuclide, in sec^{-1}, from Kocher

λ_w = decay constant for removal of activity of leaf and plant surfaces by weathering, 5.73E-07 sec^{-1} (corresponding to a 14 day half-life)

t_f = time between harvest of leafy vegetation and ingestion, 8.60E+4, in seconds

t_h = time between harvest of stored vegetation and ingestion, 5.18E+6, in seconds

f_L = fraction of annual intake of leafy vegetables grown locally, 1.0 (dimensionless)

f_g = fraction of annual intake of stored vegetables grown locally, 0.76 (dimensionless)

Parameters used in the above equation were obtained from NUREG-0133 and Regulatory Guide 1.109, Revision 1

Since the concentration of tritium in vegetation is based on the airborne concentration rather than the deposition, the Critical Organ Dose Factors (Attachment 8)for tritium were calculated by multiplying the following equation by the appropriate X/Q:

$$RM_{H^3} = K'K'''\left[U_a^L f_L + U_a^s f_g\right](DFL_i)a[0.75(0.5/H)] \qquad (29\text{-}3)$$

where:

K''' = a constant of unit conversion 1E+03 gm/kg

H = absolute humidity of the atmosphere, 8.0, gm/m^3

0.75 = the fraction of total feed that is water

0.5 = the ratio of the specific activity of the feed grass to the atmospheric water

Other parameters have been previously defined.

SUPERSEDED

ATTACHMENT 4

MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS

(01/10 - 12/10)

As required by the ODCM, Section 6.7.2.a.4, major changes to radioactive liquid, gaseous and solid waste treatment systems for the time period covered by this report are synopsized in this attachment. Supporting information as to the reason(s) for the change(s) and a summary of the 10 CFR 50.59 evaluations are included, as applicable.

There were no major changes to the radioactive liquid, gaseous, and solid waste treatment systems for 2010.

ATTACHMENT 5

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS

EFFLUENT MONITORING INSTRUMENTATION

(01/10 - 12/10)

As required by the ODCM, Sections 6.2.2.b.2 and 6.3.2.b.3, a list and explanation for extended inoperability of radioactive liquid and/or gaseous effluent monitoring instrumentation is provided in this attachment.

There was no radioactive liquid and/or gaseous effluent monitoring instrumentation out-of-service for more than 30 days during 2010.

ATTACHMENT 6

UNPLANNED RELEASES

(01/10 - 12/10)

As required by the ODCM, Section 6.7.2.a.3, a list of unplanned releases, from the site to unrestricted areas, of radioactive material in gaseous and liquid effluents occurring during the reporting period, is made in this attachment.

There were no unplanned releases during 2010 meeting the criteria of Section 6.7.2.a.3 of the ODCM from the site to unrestricted area and there were no spills, leaks, or sample results that required voluntary communication under the criteria of the NEI Ground Water Protection Initiative, NEI 07-07. However, a voluntary communication was made under NEI 07-07 due to sample results from one ground water well, Piezometer Well #3.

A sample obtained on 10/06/10 from Piezometer Well #3, was reported by the vendor to contain 1.65E4 +/- 1.94E3 pCi/L of H-3. Re-analysis of the sample, producing results of 1.89E4 +/- 2.34E3 pCi/L of H-3, confirmed the original result. No other licensed material was detected in this well or any other well. Although these results were not high enough to require voluntary communication under NEI 07-07 for ground water results, a voluntary communication was made in accordance with NEI 07-07 and plant procedures.

ATTACHMENT 7
LOWER LIMITS OF DETECTION FOR EFFLUENT SAMPLE ANALYSIS
(01/10 - 12/10)

Gaseous Effluents:

Radioisotope	Required L.L.D. µCi/mL	Typical L.L.D. µCi/mL		
Krypton - 87	1.00E-4	2.50E-8	-	7.50E-8
Krypton - 88	1.00E-4	1.50E-7	-	4.60E-7
Xenon - 133	1.00E-4	4.90E-8	-	9.90E-8
Xenon - 133m	1.00E-4	1.10E-7	-	3.80E-7
Xenon - 135	1.00E-4	4.30E-8	-	7.60E-8
Xenon - 135m	1.00E-4	2.20E-7	-	3.90E-7
Xenon - 138	1.00E-4	2.80E-7	-	7.10E-7
Iodine - 131	1.00E-12	5.40E-14	-	1.30E-13
Iodine - 133	1.00E-10	3.80E-13	-	2.50E-11
Manganese - 54	1.00E-11	6.80E-14	-	8.10E-14
Cobalt - 58	1.00E-11	5.30E-14	-	8.80E-14
Iron - 59	1.00E-11	8.20E-14	-	4.40E-13
Cobalt - 60	1.00E-11	5.20E-14	-	2.40E-13
Zinc - 65	1.00E-11	7.10E-14	-	5.20E-13
Strontium - 89	1.00E-11	1.00E-14	-	2.30E-14
Strontium - 90	1.00E-11	3.00E-15	-	6.00E-12
Molybdenum - 99	1.00E-11	3.50E-13	-	1.30E-12
Cesium - 134	1.00E-11	9.60E-15	-	3.30E-14
Cesium - 137	1.00E-11	5.20E-14	-	8.10E-14
Cerium - 141	1.00E-11	7.50E-14	-	2.80E-13
Cerium - 144	1.00E-11	3.00E-13	-	8.90E-13
Gross Alpha	1.00E-11	7.20E-15	-	1.10E-14
Tritium	1.00E-6	4.10E-09	-	8.80E-09

ATTACHMENT 7
LOWER LIMITS OF DETECTION FOR EFFLUENT SAMPLE ANALYSIS
(01/10 - 12/10)

Liquid Effluents:

Radioisotope	Required L.L.D. µCi/mL	Typical L.L.D. µCi/mL
Krypton - 87	1.00E-5	3.60E-8 - 1.70E-7
Krypton - 88	1.00E-5	6.80E-8 - 3.10E-7
Xenon - 133	1.00E-5	6.00E-8 - 1.40E-7
Xenon - 133m	1.00E-5	9.10E-8 - 3.20E-7
Xenon - 135	1.00E-5	7.20E-9 - 5.20E-8
Xenon - 135m	1.00E-5	4.40E-8 - 4.60E-7
Xenon - 138	1.00E-5	8.40E-8 - 1.00E-6
Iodine - 131	1.00E-6	2.50E-8 - 7.70E-8
Manganese - 54	5.00E-7	3.30E-8 - 6.10E-8
Iron - 55	1.00E-6	1.90E-7 - 8.60E-7
Cobalt - 58	5.00E-7	2.20E-8 - 2.10E-7
Iron - 59	5.00E-7	3.90E-8 - 7.20E-8
Cobalt - 60	5.00E-7	4.10E-8 - 8.50E-8
Zinc - 65	5.00E-7	3.10E-8 - 6.70E-8
Strontium - 89	5.00E-8	2.20E-8 - 4.20E-8
Strontium - 90	5.00E-8	1.40E-8 - 4.60E-8
Molybdenum - 99	5.00E-7	5.60E-8 - 1.80E-7
Cesium - 134	5.00E-7	9.40E-8 - 4.50E-7
Cesium - 137	5.00E-7	3.70E-8 - 8.80E-8
Cerium - 141	5.00E-7	7.10E-8 - 2.50E-7
Cerium - 144	5.00E-7	1.30E-7 - 5.00E-7
Gross Alpha	1.00E-7	2.90E-8 - 7.60E-8
Tritium	1.00E-5	2.70E-6 - 4.30E-6

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/10 - 12/10)

The Ground Water Protection Program was established to improve North Anna's management of and response to instances where the inadvertent release of radioactive substances may result in low but detectible levels of plant-related materials in subsurface soils and water. It complies with the requirements of NEI 07-07, INDUSTRY GROUND WATER PROTECTION INITIATIVE - FINAL GUIDANCE DOCUMENT. The industry initiative is intended to improve public trust and confidence in the nuclear industry through sampling and analysis of ground water and timely and effective communication with stakeholders, including the public and local, state, and federal officials.

Samples are obtained from monitoring wells installed outside the restricted area on a routine basis and analyzed by Teledyne Brown Engineering Laboratories. Additional samples are obtained from wells located inside the restricted area and analyzed by Teledyne Brown. Samples are obtained from sumps and yard drains on a routine basis and analyzed onsite. Finally, samples may be obtained more frequently than routine. These samples may be analyzed on-site or by a vendor such as Teledyne Brown. The required Lower Limits of Detection, LLDs, and reporting limits for the ground water detection program are those associated with the radiological environmental program as listed in Attachments11 & 12 to VPAP-2103N, which is attached to this document.

On the following pages is a summary of the samples and results of the ground water protection program taken for calendar year 2010. All results are report in pCi/L. An "N/A" indicates a sample analysis was not performed for that sample. An "ND" indicates an analysis was performed but the result was less than the Minimum Detectable Activity, MDA, and the required LLD. If a result is greater than the MDA, but less than the LLD the result is listed. Some of these results may be false positives, due to the analysis software or interferences from naturally occurring radioactivity. In these cases, instead of the value, an explanatory footnote is provided.

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/10 - 12/10)

Sample	Date	Sample Media	H-3	Particulates	I-131	Sr-89/90	Fe-55	Ni-63	Alpha TRU	Pu-241
Subsurface Drain Header	02/09/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Structure Outfall	02/09/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Structure Outfall	02/09/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Discharge Canal Outfall	02/09/10	Water	2720	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	03/04/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	03/04/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump East (Inside)	03/04/10	Water	1630	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump South (Outside)	03/04/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 ABGWMS	03/04/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 ABGWMS	03/04/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW #1	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #2	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #4	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #1	04/22/10	Water	Insufficient volume to sample							
TTW #2	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #3	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #4	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #5	04/22/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
PZ #1	04/22/10	Water	ND	ND	ND	ND	ND	N/A	N/A	N/A
PZ #2	04/22/10	Water	ND	ND	ND	ND	ND	N/A	N/A	N/A
PZ #3(1)	04/22/10	Water	7330, 4690, 4710	ND	ND	ND	ND	ND	N/A	N/A
Subsurface Drain Header	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Structure Outfall	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Structure Outfall	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Discharge Canal Outfall	05/15/10	Water	2808	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump East (Inside)	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump South (Outside)	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 ABGWMS	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 ABGWMS	05/15/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ISFSI Well #1	06/11/10	Water	ND	ND	ND	ND	N/A	N/A	N/A	N/A
ISFSI Well #4	06/11/10	Water	ND	ND	ND	ND	N/A	N/A	N/A	N/A
BTW #1	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #2	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #4	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #1	06/26/10	Water	Insufficient volume to sample							
TTW #2(2)	06/26/10	Water	ND	ND	ND(2)	N/A	N/A	N/A	N/A	N/A
TTW #3	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A

(1) Original result was 7330 pCi/L. Re-analysis of sample produced next two results.
(2) I-131 considered a false positive, due to interference from ingrowth of naturally-occurring radioactive isotopes. Sample counts activity increased with multiple delayed counts. This indicates the activity is not due to I-131.

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/10 - 12/10)

Sample	Date	Sample Media	H-3	Particulates	I-131	Sr-89/90	Fe-55	Ni-63	Alpha TRU	Pu-241
TTW #4	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #5	06/26/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
PZ #1	06/20/10	Water	ND	Insufficient volume for these analyses						
PZ #2(1)	06/20/10	Water	ND	ND	ND(1)	N/A	N/A	N/A	N/A	N/A
PZ #3	06/20/10	Water	6350	ND	ND	N/A	N/A	N/A	N/A	N/A
PZ #3(2)	07/18/2010	Water	7350, 7680	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Structure Outfall	08/11/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Structure Outfall	08/11/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Discharge Canal Outfall	08/11/10	Water	2280	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	08/26/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	08/26/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump East (Inside)	08/26/10	Water	1870	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump South (Outside)	08/26/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 ABGWMS	08/26/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 ABGWMS	08/26/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #1	09/06/10	Water	ND	Insufficient volume for these analyses						
PZ #2	09/06/10	Water	ND	Insufficient volume for these analyses						
PZ #3	09/06/10	Water	3860	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #1	09/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #2(3)	09/11/10	Water	ND	ND	ND(3)	N/A	N/A	N/A	N/A	N/A
BTW #4(3)	09/11/10	Water	ND	ND	ND(3)	N/A	N/A	N/A	N/A	N/A
TTW #1	09/11/10	Water	Insufficient volume to sample							
TTW #2(3)	09/11/10	Water	ND	ND	ND(3)	N/A	N/A	N/A	N/A	N/A
TTW #3	09/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #4(3)	09/11/10	Water	ND	ND	ND(3)	N/A	N/A	N/A	N/A	N/A
TTW #5(3)	09/11/10	Water	ND	ND	ND(3)	N/A	N/A	N/A	N/A	N/A
U-1 ABGWMS	10/01/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 ABGWMS	10/01/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(2)	10/06/10	Water	16500, 18900	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3 (Vendor)	10/18/10	Water	3660	ND	ND	ND	ND	ND	ND	ND
PZ #3(2) (In-house)	10/18/10	Water	4430	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3 (Vendor)	10/30/10	Water	5030	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(2) (In-house)	10/30/10	Water	4270	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subsurface Drain Header	11/02/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Structure Outfall	11/02/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Structure Outfall	11/02/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Discharge Canal Outfall	11/02/10	Water	4270	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3 (Vendor)	11/05/10	Water	5390	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) Only about 809 mL available for analysis due to low water level in well. I-131 (LL) not able to be performed. I-131 MDA was 9.34 pCi/L, which is less than the non-drinking water LLD of Attachment 11 to VPAP-2103N.
(2) PZ Wells #1 & 2 were sampled in conjunction with PZ #3. However, there was insufficient volume to obtain a sample in either well
(3) I-131 considered a false positive, due to interference from ingrowth of naturally-occurring radioactive isotopes. Sample counts activity increased with multiple delayed counts. This indicates the activity is not due to I-131.

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/10 - 12/10)

Sample	Date	Sample Media	H-3	Particulates	I-131	Sr-89/90	Fe-55	Ni-63	Alpha TRU	Pu-241
PZ #3(1) (In-house)	11/05/10	Water	4390	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	11/13/10	Water	4360	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	11/17/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	11/17/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump East (Inside)	11/17/10	Water	1290	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump South (Outside)	11/17/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 ABGWMS	11/17/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 ABGWMS	11/17/10	Water	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	11/20/10	Water	5950	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	11/26/10	Water	5100	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	12/03/10	Water	3900	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #1	12/10/10	Water	Insufficient volume to sample							
PZ #2	12/10/10	Water	Insufficient volume to sample							
PZ #3 (Vendor)	12/10/10	Water	3110	ND	ND	N/A	N/A	N/A	N/A	N/A
PZ #3 (In-house)	12/10/10	Water	1710	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW #1	12/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #2	12/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
BTW #4	12/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #1	12/11/10	Water	Insufficient volume to sample							
TTW #2(2)	12/11/10	Water	ND	ND	ND(2)	N/A	N/A	N/A	N/A	N/A
TTW #3	12/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #4	12/11/10	Water	ND	ND	ND	N/A	N/A	N/A	N/A	N/A
TTW #5(2)	12/11/10	Water	ND	ND	ND(2)	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	12/17/10	Water	2790	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	12/21/10	Water	3350	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ #3(1) (In-house)	12/30/10	Water	1550	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) PZ Wells #1 & 2 were sampled in conjunction with PZ #3 on a monthly and weekly basis. However, there was insufficient volume to obtain a sample in either well.

(2) I-131 considered a false positive, due to interference from ingrowth of naturally-occurring radioactive isotopes. Sample counts activity increased with multiple delayed counts. This indicates the activity is not due to I-131.

ATTACHMENT 9
CARBON-14 CALCULATIONS
(01/10 - 12/10)

Carbon-14,C-14, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Due to its long half-life, 5730 years, a significant portion of the C-14 from this testing is still present in the environment. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC has recommended that U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. At North Anna, improvements over the years in fuel performance have resulted in a decrease in the amount and distribution radionuclides released to the environment in gaseous effluents. As a result, C-14 has become a "principal radionuclide" for the gaseous effluent pathway at North Anna, as defined in Regulatory Guide 1.21, Rev. 2. Because the dose contribution of C-14 to liquid radioactive waste is a small fraction of the dose compared to other nuclides, evaluation of C-14 in liquid effluents is not required by Ref. Reg. Guide 1.21, Rev. 2.

The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation. North Anna utilized methodology in EPRI Report, Estimation of C-14 in Nuclear Power Gaseous Effluents. Based on this document, at full capacity, North Anna would generate and release about 23 Ci of C-14 per year. Since the units did not operate at full power for 100% of the year, this value was corrected for the capacity factor of each unit yielding an estimated 17 Ci of C-14 produced and released. North Anna assumed that the fractional release of gaseous C-14 in any quarter and pathway could be approximated by the fraction of noble gasses released via that pathway in that quarter.

Most C-14 species initially produced in a PWR are organic, e.g., methane. C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment, a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic. North Anna used a value of 70% organic and 30% CO_2 in its calculations.

Public dose estimates from airborne C-14 were performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released at North Anna is estimated to be 9.68E-2 mrem from the inhalation pathway, or 6.45E-3%TS and 1.16 mrem from the ingestion pathway or 3.87% of the 10CFR50, Appendix I, ALARA design objective of 15 mrem/yr per unit. In both cases the critical organ was determined to be the child's bone.